UNIVERSIDAD COMPLUTENSE DE MADRID
FACULTAD DE CIENCIAS ECONÓMICAS Y EMPRESARIALES

TESIS DOCTORAL

Essays on behavioral reponses to taxation

Ensayos sobre las respuestas de los contribuyentes ante variaciones en los impuestos

MEMORIA PARA OPTAR AL GRADO DE DOCTOR

PRESENTADA POR

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Madrid

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Essays on Behavioral Responses to Taxation
Ensayos sobre las Respuestas de los Contribuyentes ante Variaciones en los Impuestos

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DOCTORAL DISSERTATION

Essays on Behavioral Responses to Taxation

Ensayos sobre las Respuestas de los Contribuyentes ante Variaciones en los Impuestos

by

Ana Gamarra Rondinel

Supervisors:

María Arrazola Vacas

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Madrid, 2019

A mi querido padre, Leopoldo

A mi compañero de camino, Mario

Acknowledgements

First, I would like to express my deepest gratitude to my supervisors, María Arrazola and José. F. Sanz-Sanz, for their guidance and assistance through the creation of this thesis. I am deeply grateful to both for having placed their trust in me from the beginning. Their advices and support have enormously enriched the contribution of my research.

I am grateful also to the Pontifical Catholic University of Peru and to the University Carlos III of Madrid, in particular to Manuel Estela for having taught me the importance of public finance. I further want to thank Jean Hindriks for his support during my years at the School of Economics at the Université catholique de Louvain. Those years provided me of the necessary tools to perform rigorous and independent research. I want to thank the Spanish Institute for Fiscal Studies for sharing their available data, especially to César Pérez. This thesis wouldn't be possible without his generosity. I further want to thank Funcas for their financial support during the completion of my thesis.

Special gratitude goes to the journals *Páginas*, *Alandar* and *Análisis Tributario (AELE)* for giving me always a space on their pages to reflect on the subjects developed in this thesis. This project wouldn't have been possible without the support of some special persons who have encouraged me always: my group of JEC (Álvaro, Carmen, Eduardo, Mayte, Maitane, Teresa), Lala, Luis Fernando, José Ramón, Pierina, Carolina, Orean and Mariachiara. Special thanks are needed for Victoria and Jesús, for making of Spain my home. Last, but not least, I dedicate this thesis to the two most important persons in my life to my father and to Mario. I am in debt to both for their endless love, faith in my capabilities and for their support to pursue of my academic goals.

Contents

Summary

This thesis is entitled *Essays on Behavioral Responses to Taxation* and consists of five chapters. The first one describes the framework in which the thesis is placed, the three subsequent chapters present the major studies and findings, and the last one states the general conclusions.

In the second chapter, I provide empirical evidence on taxpayers' responsiveness to personal income taxation through the estimation of the elasticity of taxable income for Spain. Applying the bunching approach and an annual cross-section data that covers all income tax returns for 2010-2014, I find clear evidence of bunching behavior at the first four tax kinks of the Spanish Personal Income Tax created by the progressivity of the tax and intensified by the tax reform of 2011. Further exploration confirms the existence of considerable heterogeneity in the value of the elasticity depending on taxpayers' characteristics. By analyzing the anatomy of responses, I find that much of the behavioral response to kinks in the Spanish tax system is the result of married taxpayers using itemized deductions to minimize their tax liabilities.

In the third chapter, I assess the impact of the 2011 tax reform on tax revenue, well-being and efficiency. Using the 2SLS method and a panel from the Spanish Personal Income Tax for the years 2009-2014, considerable heterogeneity is detected in the values of the elasticity of taxable income and of the marginal cost of public funds. Both depending on the socio-economic characteristics of taxpayers and the timing of the responses. The marginal welfare cost of raising an extra euro of tax revenue is estimated to be substantial in the year immediately after the tax reform. In particular, findings suggest that efficiency losses are considerable among Catalan taxpayers and self-employed individuals. Also, income shifting between the two tax bases of the income tax is found to have an important role in the evaluation of the welfare costs.

In the fourth chapter, I analyze empirically the trade-off between revenue and production efficiency in the choice of tax instruments in Argentina. I use an optimal tax model which I extend to account for turnover evasion. Moreover, I exploit the introduction of a production inefficient tax policy, the Simplified Tax Regime, which affect firms' behavior on compliance and real output. Based on the bunching approach and on administrative tax data covering all Corporate

Income Tax returns for the years 1997-2011, I find evidence of bunching behavior among medium firms in all the period. The results suggest that the introduction of the Simplified Tax Regime provides medium enterprises with an additional incentive to reduce turnover ('legally' or 'illegally') and to comply with costs in order to take advantage of the new tax regime.

Summary (in Spanish)

Esta tesis se titula *Ensayos sobre las Respuestas de los Contribuyentes ante Variaciones en los Impuestos* y consta de cinco capítulos. El primero describe el marco en el que se encuadra la tesis, los tres capítulos siguientes presentan los estudios y resultados principales, y el último enuncia las conclusiones generales.

En el segundo capítulo, proporciono evidencia empírica sobre las respuestas de los individuos al Impuesto sobre la Renta de las Personas Físicas (IRPF) a través de la estimación de la elasticidad de la renta gravable para España. En este capítulo utilizo el método del *bunching* y una base de datos anual de corte transversal de las declaraciones del IRPF para el periodo 2010-2014. Encuentro clara evidencia de *bunching* en los primeros cuatro *kinks* del IRPF causados por la progresividad del impuesto e intensificados por la reforma tributaria de 2011. Un análisis más profundo del *bunching* confirma la existencia de una gran heterogeneidad en el valor de la elasticidad en función de las características socio-económicas de los contribuyentes. Al analizar la anatomía de las respuestas, encuentro que gran parte de éstas corresponden a contribuyentes casados que utilizan las deducciones a la base imponible para minimizar sus obligaciones tributarias.

En el tercer capítulo, evalúo el impacto de la reforma fiscal de 2011 en la recaudación, en los costes de eficiencia y en el bienestar. En este capítulo utilizo el método 2SLS y una base de datos panel del IRPF español para el periodo 2009-2014. Detecto una heterogeneidad importante en los valores de la elasticidad de la renta gravable y del coste marginal de los fondos públicos, según las características socio-económicas de los individuos y el tiempo de las respuestas. El coste marginal de recaudar un euro adicional en este impuesto es sustancial en el año inmediatamente después de la reforma fiscal. En particular, los resultados sugieren que los costes de eficiencia son considerables entre los contribuyentes catalanes y los autónomos. A su vez, se observa que el trasvase de renta entre las dos bases del IRPF desempeña un papel importante en la evaluación de los costes de bienestar.

En el cuarto capítulo, analizo empíricamente el equilibrio entre ingresos y eficiencia productiva en la elección de instrumentos fiscales en Argentina. En este capítulo utilizo un modelo de imposición óptima, el cual extiendo para incorporar la evasión en el volumen de ventas. Asimismo, exploro la aplicación de una política fiscal ineficiente de producción, el Régimen Simplificado, que afecta el comportamiento de las empresas en cuanto al cumplimiento y la producción. Además, hago uso del método *bunching* y de una base de datos anual de corte trasversal del Impuesto de Sociedades para el periodo 1997-2011. Encuentro evidencia de *bunching* entre las empresas de tamaño mediano a lo largo de todo el periodo. Los resultados sugieren que la introducción del Régimen Simplificado brinda a las empresas medianas de un incentivo adicional para reducir el volumen de sus ventas ('legamente' o 'ilegalmente') y para cumplir con la declaración de sus costes, con el fin de beneficiarse del nuevo régimen fiscal.

Chapter 1

Introduction

Taxes are part of one of the two channels (i.e. price intervention and regulation) used by governments to intervene in the economy. Governments raise taxes to finance public goods and to redistribute income; however, by doing so they affect quantities and market prices and, in consequence, they have an effect on distribution and efficiency. The effect on distribution refers to the incidence of taxation, while the effect on efficiency refers to the deadweight loss or the surplus lost created by a tax modification. At the heart of public finances is the analysis of both; however, the efficiency costs of taxation are of particular interest for this thesis.

The efficiency costs of taxation arise because in order to generate €1 of tax revenue, taxpayers' welfare fall by more than €1 because of the distortion created by the tax on taxpayers' behavior. The insight behind this is that taxes create a number of incentives that lead households and firms to modify their economic decisions in order to minimize the effect of a tax change, or simply to reduce their tax bill paid. So, tax policies induce economic agents to alter their behavior and to respond through; for example, evasion, avoidance or real responses. All these behavioral responses affect reported income and therefore tax revenue. Then, the magnitude of these responses is crucial in the construction of tax policies because it has implications on the design of the tax system and the revenue capacity of the tax structure (Feldstein 1995). But, understand the effect of tax rates on tax revenue requires a measure that captures all these potential responses to taxation. To address this, public finance economists have focused their attention on estimating the elasticity of behavior with respect to taxes.

Sanz-Sanz *et al.* (2015) identify three generations in this literature. The first generation focused on the effect of income taxes on the number of hours worked and on the decision to whether participate in the labor market. In effect, this generation centered its attention on the elasticity of labor supply. It was until Feldstein (1995, 1999) when an alternative methodology erupted in the public economic literature and gave birth to the second generation. The main contribution of Feldstein was to consider labor supply as only one response among all the potential responses to income taxation. At the margin, as Feldstein stated, all behavioral responses are revealed on reported income and can be captured in a single measure: the Elasticity of Taxable Income (ETI). This supposed a turning point in the evaluation of fiscal distortions because the ETI became a sufficient statistic for calculating the deadweight loss caused by a tax change (Sanz-Sanz 2016). In other words, the ETI eliminated the need to combine each behavioral adjustment in a structural model (Creedy and Gemmell 2013). This advantage was used in the computation of various welfare measures as the marginal excess burden (MEB), the marginal welfare cost (MWC) and the marginal cost of public funds (MCF).

In the last decades there has been a growing literature on the ETI for U.S. and for non-U.S. countries as Canada (Sillamaa and Veall 2011; Saez and Veall 2005), Norway (Aarbu and Thoresen 2001), Sweden (Blomquist and Selin 2010; Holmlund and Söderström 2007), Japan (Moriguchi 2010), Finland (Pirttilä and Selin 2011), Denmark (Kleven and Schultz 2013), New Zealand (Claus *et al.* 2012), Hungary (Bakos *et al.* 2008; Kiss and Mosberger 2015), Spain (Badenes 2001; Sanmartin 2007; Arrazola *et al.* 2014; Sanz-Sanz *et al.* 2015; Díaz and Onrubia 2018). The development of more robust econometric methods and the increasing availability of administrative tax data have been the causes of the emergence of these studies. As expected, this new literature – considered the third generation – improved the estimation methods of the ETI and gave rise to a number of critiques. One of these critiques is the omission of the income effect in the quantification of the ETI. The literature has not yet reached a consensus on the size of this effect. Nevertheless, lately some studies (Gruber and Saez 2002; Weber 2014; Sanz-Sanz *et al.* 2015; Burns and Ziliak 2017) based on different econometric techniques have concluded that this effect is small and insignificant.

Another important critique is the presence of fiscal externalities in the estimation of the elasticity. The accuracy of the ETI as a sufficient indicator for welfare analysis has been questioned because it takes all behavioral responses as full deadweight losses. However, some responses generate externalities that reduce the government leakage, e.g. the fines paid for tax evasion, the charitable contributions and the income shifted between tax bases (Chetty 2009). A third critique is the large degree of variation on the size of the ETI. As it is not a fixed parameter, the elasticity depends on the specific tax structure of each country, the different approaches applied in the estimation of the parameter, the type of data used, the reform examined, the period analyzed and the sample used. As a result, it is difficult to compare the ETI across countries and to find a consensus value of this parameter, Spain is a good illustration of this: 1.54 (Arrazola *et al.* 2014), 0.67 (Sanz-Sanz *et al.* 2015), 1.31-1.54 (Arrazola and Hevia 2017) and 0.41 (Díaz and Onrubia 2018). Modern literature has introduced other aspects of taxpayers' decisions on consumption, investment, savings, maternity, education, labor mobility and emancipation. Yet, few studies (Doerrenberg, *et al.* 2017; Seim 2017; Le Maire and Schjerning 2013; Harju and Matikka 2014; Adam *et al.* 2015) examine the adjustment channels underlying the ETI; consequently, the behavioral responses responsible for the change in reported income remain unknown. This constitutes the fourth critique in the literature.

The critiques highlighted here can be seen as challenges or gaps in the literature that need to be faced. For this reason, the present thesis aims to answer to the following questions: (i) Do economic agents respond to taxation? (ii) Who are the most responsive? (iii) How do they respond, through which channels (i.e. the anatomy of the responses)? (iv) When do they respond most, at the short-, medium-, or long-run (i.e. the timing of the responses)? On the whole, this thesis pretends to provide quantitative measures of the distortions caused by taxes on the behavior of economic agents.

For doing so, this thesis relies on the 2SLS method and the bunching approach to provide consistent estimates of the ETI. On one side, the 2SLS regression is the most common method used in the literature since Auten and Carroll (1999) and Gruber and Saez (2002). It compares reported income in the pre- and post- tax reform periods and deals with the mean reversion problem, the heterogeneous income trends and the potential endogeneity of the marginal tax rate. On the other side, the bunching approach is the latest method developed in the literature. It was originally proposed by Saez (2010) and then, extended by Chetty *et al.* (2011). It is a visual technique which relies on the identification of agglomerations (or bunchings) in the density distribution of taxable income. The discrete jumps of marginal tax rates at bracket cutoffs (i.e. kinks) introduce an incentive to taxpayers for moving from a point above the cutoff to a point just below it by reducing taxable income through legal or illegal channels (Kleven 2016). Therefore, looking for bunching around kink points provides evidence of behavioral responses to taxation and more important, according to Saez (2010), the ETI can be inferred from the amount of excess bunching. Nowadays, more and more studies are applying this approach to different environments as optimization frictions (Bastani and Selin 2014), inattention (Chetty 2009), collective agreements (Piketty *et al.* 2013), notches (Kleven and Waseem 2013) and randomized field experiments (Kleven *et al.* 2011).

The major studies and findings of this thesis are presented in three different chapters. Chapters 2 and 4 use the novel bunching approach to provide visual evidence and empirical estimations of households' and firms' responses to taxation. Whereas, Chapter 3 uses the 2SLS method to estimate the ETI and assess the impact of behavioral responses on tax revenue, efficiency and welfare. In this manner, the present thesis contributes to the literature by providing two key parameters: the elasticity of taxable income and the marginal costs of public funds.

Chapter 2, titled *The Elasticity of Taxable Income: Bunching Evidence from Spain*, analyzes the behavioral responses of Spanish taxpayers to marginal tax rates. In particular, the study exploits the implementation of the Royal Decree-Law 20/2011. This reform provides a natural experiment suitable for this kind of study because it increased marginal tax rates leaving income thresholds unchanged. Moreover, I use the bunching approach and an annual cross-section data of income tax returns from the Spanish Institute for Fiscal Studies over 2010-2014 period. This chapter has four main results. First, I find clear and significant bunching at the first four tax kinks of the Spanish PIT schedule. Interestingly, the detected bunching is not a spike exactly at the kink, instead it takes different forms such as bunching-holes, holes, asymmetric bunching, agglomerations and interior bunching. Second, I show evidence that the tax reform of 2011 induced taxpayers to react more to taxation, this result is more evident in married couples with no child and in one-parent households. Third, I find that the tax filers responsible of the majority of bunching are women (in married couples with no child), men (in married couples with one child), wage earners and taxpayers reporting individually. Fourth, by analyzing the anatomy of responses, results suggest that most taxpayers reduce their taxable income by using itemized deductions, I find that this effect is more pronounced in men, in married couples and in wage earners. Thence, the importance of this chapter is threefold. First, it identifies the demographic characteristics of the taxpayers responsible of bunching and the potential channels through which they modify their taxable income. Second, this chapter relies on a new method free of potential mean reversion, heterogeneous income trends and endogeneity bias, the issues commonly faced in the estimation of the ETI. Third, Chapter 2 contributes to the literature by classifying different forms of bunching for the first time.

Chapter 3, entitled *How much does it cost to Spanish taxpayers to raise an additional euro of tax revenue?* has two goals. On one side, calculate the costs of financing incremental government spending associated with the implementation of the aforementioned reform in the Spanish PIT schedule. On the other side, show the effect of income shifting on the welfare analysis of income taxation. For doing so, I estimate the ETI by 2SLS correcting for mean reversion, heterogeneous income trends and endogeneity bias. Based on these estimates, I determine the impact of the reform on tax revenue, well-being and efficiency. The data source for this exercise is a panel of tax returns from the Spanish Institute for Fiscal Studies over 2009-2014 period. This Chapter has four main results. First, the elasticity estimates suggest that women are more responsive to tax changes than men. Second, findings show that raising an extra euro of tax revenue entails substantial efficiency costs, especially in the year immediate to the reform. On average, for the entire population, the MCF is: 3.94 (in 2012), 2.47 (in 2013) and 1.88 (in 2014). In consequence, an important fraction of tax revenue is lost because of efficiency costs. The fraction of tax revenue lost through behavioral responses at national level is approximately: 73% (in 2012), 58% (in 2013) and 46% (in 2014). Third, results indicate that the welfare loss from raising an additional euro of tax revenue is not the same for all Spanish taxpayers. In particular, I find that it is especially high for Catalan taxpayers and for self-employed individuals. Fourth, results show that welfare costs are quite sensitive to the introduction of income shifting responses. When I assume that half of income shifts from the general base to the savings base, the fraction of tax revenue lost due to behavioral responses drops from 73% to 52% (in 2012), from 58% to 41% (in 2013) and from 46% to 32% (in 2014). In this sense, the contributions of this chapter are threefold. First, illustrate how increases in tax rates are likely to be revenue-enhancing for some groups of the population. Second, contribute to the literature by analyzing the implications of income shifting on well-being. Third, provide new ETI estimates for Spain using different identification specifications to control for mean reversion and endogeneity bias.

A key idea in public economics is that optimal tax policies and tax instruments can ensure production efficiency even in second-best environments. This theoretical prediction has been widely accepted and put into practice in developed and developing countries. Yet, it has been derived from models that ignore tax evasion. Once enforcement constraints are acknowledged, contrary to the theoretical prediction, production efficiency is no longer the centerpiece of the model while instead revenue efficiency becomes more relevant. Accordingly, Chapter 4 of this thesis, titled *Evasion vs. Real production responses to Taxation among firms: Bunching Evidence from Argentina*, analyzes empirically the trade-off between revenue and production efficiency in the choice of tax instruments in Argentina. In order to do this, I exploit a production inefficient tax policy called the Simplified Tax Regime, according to which firms are taxed either on their profits or turnover depending on which tax liability is larger. Moreover, I extend the model of Best *et al.* (2014) by introducing turnover evasion, in order to account for the Argentinean context. I use administrative data from the Federal Administration of Public Revenue (AFIP, in Spanish) covering the tax returns of all firms subject to corporate income tax between 1997 and 2011. Furthermore, I relied on the bunching approach to analyze this policy based on the idea that the simplified regime gives rise to non-standard kink points, due to the joint and discontinuous change of the tax rate and the tax base at a cutoff. As a result, such kinks influence the behavior of firms in terms of compliance and real production differently, and give rise to an excess mass around the kink. This Chapter has three main findings. First, the introduction of the policy provides small and medium enterprises (SMEs) with an additional incentive to reduce their turnover (‘legally’ or ‘illegally’) and to comply with costs. Second, I find that in Argentina this phenomenon is mostly the result of evasion responses. Third, in line with existing research (Devereux *et al.* 2012; Dekker *et al.* 2016), bunching is asymmetric around a profit rate of 0.09. This provides strong evidence that firms respond to the taxation component of the policy. Therefore, the contributions of this chapter to the literature are threefold. First, provide direct empirical evidence on firms’ margin responses to a widespread and questionable policy in Latin America with scarce quantitative evidence. Second, contribute to the CIT’s literature since the majority of studies focus on the effect of marginal tax rates in the context of the PIT. Third, enrich the understanding of the taxation of SMEs and domestic revenue mobilization in developing countries.

Following from this Introduction, in Chapters 2 to 4 the quoted studies are presented. The thesis ends with some general conclusions in Chapter 5.

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Chapter 2
The Elasticity of Taxable Income: Bunching Evidence from Spain[1]

2.1 Introduction

This chapter is about analyzing the effects of tax policies on the behavior of economic agents. It is well-known that taxes distort the decisions of taxpayers. Taxes change taxpayers' behavioral economic pattern by substituting away from taxed to untaxed activities until the marginal cost of tax saving equals the marginal return of it (Slemrod 1998; Slemrod and Kopczuk 2002). In other words, tax policies result in behavioral responses intended to minimize taxpayers' tax liability and tax payment. Those responses could take the form of tax avoidance, tax evasion or real responses which - under some assumptions - can be seen as "sources or symptoms of inefficiency" (Saez *et al.* 2012, p.4). As a consequence, a central topic in public economic is the assessment of those sources of inefficiency that produce welfare losses. For this reason, "the notion of a behavioral elasticity occupies a critical place in the economic analysis of taxation" (Saez *et al.* 2012, p. 3). But, it is since Feldstein's (1995, 1999) pioneering papers that a key parameter emerged, the elasticity of taxable income (ETI). Based on this seminal work, the ETI can determine the welfare losses generated by the effects of tax rate modifications on taxpayers' behavior. Consequently, several studies considered the ETI as a sufficient statistic for welfare analysis of the tax system[2].

A large literature has come out since then with the objective to measure responses of reported income to changes in marginal tax rates (MTRs). A recent strand of the literature uses a non-

[1] I would like to acknowledge a research grant from FUNCAS. This paper was presented at the 75th Annual Congress of the International Institute of Public Finance (Glasgow, August 2019).

[2] However, some studies have recognized its limitations as the static frictionless setting of the model. Le Maire and Schjerning (2013), for example, extended the static model into a dynamic one to account for inter-temporal income shifting through retained earnings in Denmark. On the other hand, Chetty *et al.* (2011) and Adam *et al.* (2015) introduced optimization frictions to understand why individuals do not re-optimize their decisions to respond to tax incentives and, in this way, explain the low values of the labor supply elasticities.

parametric method - called the bunching approach - to estimate the ETI[3]. This method exploits the clustering behavior of taxpayers at (convex) kinks of non-linear tax systems. Using this approach has several advantages. First, it is not susceptible to endogenous bias; second, looking for bunching around kink points provides evidence of behavioral responses to taxation, and more importantly - based on Saez (2010) work - the ETI can be inferred from the amount of excess bunching. Therefore, the goal of this study is to analyze the behavioral responses of Spanish taxpayers to MTRs. I will address questions such as: Are Spanish taxpayers sensitive to the Personal Income Tax (PIT)? Who are the taxpayers most sensitive? Which are the channels they use to reduce their reported income? For doing so, I use micro-data collected and prepared by the Tax Administration and the Institute for Fiscal Studies. It is an annual cross-section data that covers all income tax returns for 2010-2014 and with sampling weights to reflect all the population.

Moreover, I rely on the basic micro-economic framework with two goods (consumption and leisure). From this basic model, I use the bunching approach to obtain the excess mass of taxpayers needed in the estimation of the ETI. Intuitively, the introduction of discontinuities (i.e. kinks) in the budget set of individuals induce taxpayers to reduce their reported taxable income legally or illegally in order to lower their tax liability and hence, their tax payment. Those responses lead to taxpayers' agglomerations around kinks in the density distribution of taxable income. The empirical bunching is the only parameter that needs to be estimated in order to calculate the elasticity; for doing so, I use an econometric method developed by Saez (2010).

This chapter has four main results. First, I find clear and significant bunching at the first four tax kinks of the Spanish PIT schedule, using the taxable income and the gross income. This finding suggests not only the conventional evidence of behavioral responses to taxation, but also the possibility of misperception. In addition, in line with the literature, I find that bunching is not a spike exactly at the kink, instead it can take different forms as bunching-holes, holes, asymmetric bunching, agglomerations and interior bunching due to the presence of adjustment costs, optimization frictions and psychological components. Second, I find evidence that the tax reform of 2011 induced taxpayers to react more to taxation, these responses are observed among several Autonomous Communities (ACs) and different socio-economic groups, being more evident in married couples with no child and in one-parent households. Third, I find that the tax filers responsible of the majority of bunching are: women (in married couples with no child), men (in

[3] Sanz-Sanz *et al.* (2015) classified the ETI literature in three generations based on the method applied and the accuracy of the estimations. The first generation analyzed tax distortions focus on labor supply responses. The second generation extended the effect of taxation on further behavioral responses as decisions on savings, investment, consumption, tax avoidance, etc. And, the third generation, took advantage of more robust econometric methods and the availability of administrative tax data to continue with the evaluation of those behavioral responses. According to the authors, the bunching approach is part of this last generation.

married couples with one child), wage earners and taxpayers reporting individually. By analyzing the anatomy of responses, I find that most taxpayers reduce their taxable income by using itemized deductions. Further exploration reveals that taxpayers at the second, third and fourth tax kinks use deductions to pension contributions to bunch at those kinks. Whereas, taxpayers at the first tax kink use the deduction for joint declaration to bunch at that kink. Finally, I find that this effect is mainly in men, in married couples and in wage earners.

The importance of this research is threefold. First, further interpretation is needed about the precise nature of individuals' responses in order to construct an appropriate policy design. I address this gap by identifying the demographic characteristics of the taxpayers responsible of bunching and the potential channels through which they modify their taxable income. Second, I rely on a new method free of potential mean reversion, heterogeneous income trends and endogeneity bias, the issues commonly faced in the estimation of the ETI. Finally, this study contributes to the literature by defining different forms of bunching: (i) bunching-hole (a hole in the distribution just after or before a bunching), (ii) hole (a missing mass in the distribution), (iii) agglomeration (a diffuse mass around tax kinks), (iv) interior bunching (bunching within a tax bracket) and (v) asymmetric bunching (bunching placed slightly below or above tax kinks)[4].

This chapter is organized as follows. Section 2 develops the theoretical and empirical methodology that allows the estimation of the ETI using the bunching approach. Section 3 describes the institutional setting and data. Sections 4 and 5 set out the results of the analysis. Section 6 briefly concludes.

2.2 Theoretical framework

In this section, first I present the simple one-period model with two goods (leisure and consumption) that set the effect of taxes on individuals' behavior along the intensive margin. Bunching theory predicts that when individuals have convex preferences, smoothly distributed among the population, the existence of kinks in the budget set elicit behavioral responses that create bunching around them (Kleven 2016; Adam *et al* 2015). Based on this model, I then outline the empirical methodology proposed by Saez (2010) to derive the ETI, i.e. the bunching approach.

[4] Most of the ETI literate is for U.S., see Gruber and Saez (2002) and Saez *et al.* (2012) for an overview. As far as we are concerned, Esteller-Moré and Foremny (2016) is the only study that use the bunching approach to estimate the ETI in Spain. They find no behavioral responses for the period 2009-2012. For a literature review of the ETI in Spain, see Arrazola and Hevia (2017).

2.2.1 Model

I consider the static frictionless model underlying the bunching estimation technique, proposed by Saez (2010). Let's assume a situation where individuals maximize a quasilinear, iso-elastic utility function $u(c,z) = c - \frac{n}{1+1/e}\left(\frac{z}{n}\right)^{1+1/e}$ subject to the individual budget constraint $c = z - T(z) + R$; where c is consumption, z is earnings, n is the ability parameter, R represents non-labor income and $T(z)$ denotes the tax function. The utility function represents individual's preferences for consumption and leisure. From the maximization problem I get the amount of reported income $z = n(1-\tau)^e$ that reflects individual's skills, tastes for labor and opportunities for avoidance (Saez *et al.* 2012).

Assume that the baseline of this model - before the introduction of a kink - is a linear tax system $T(z) = \tau_0 z$ and incomes are smoothly distributed as $h_0(z)$. A convex kink is introduced at an income level z^*, such that for income $z > z^*$ the tax rate $\tau_1 > \tau_0$ applies. Therefore, this discrete increment in the MTR modifies the tax system as follows: $\tau = \tau_0$ before the kink and $\tau = (\tau_0, \tau_1)$, $\tau_1 > \tau_0$ after the kink[5]. This modification on the tax system changes the income distribution as individuals adjust their income to the new scenario, thus the new distribution of income is $h(z)$, see Fig. A.1. Consequently, the affected and unaffected individuals from the introduction of the kink are the following:

- *Non-bunchers*: Individuals with $z \leq z^*$ before the kink who are unaffected because their income is unchanged and hence, their income distribution is as the baseline $h(z) = h_0(z)$.
- *Bunchers*: Individuals with $z \in [z^*, z^* + dz^*]$ before the kink who reduce their income towards z^* creating an excess mass of taxpayers at $z^*, B = \int_{z^*}^{z^*+\Delta z^*} h_0(z).\partial z.$
- *Potential bunchers*: Individuals with $z > z^* + dz^*$ before the kink who reduce their income towards a segment $[\,z^*, z^* + dz^*]$ filing up the hole left by bunchers.

Three observations deserve our attention. First, I ruled out income effects, consequently the ETI reflects only the compensated elasticity and "takes this simple form whatever the size of the jump in rates" (Saez 1999, p. 16). In line with previous studies, I avoid income effects as those are considered insignificant and small, even for large kinks (Gruber and Saez 2002; Saez 1999; Bastani and Selin

[5] Subscripts do not refer to different years on a timeline, τ_0 is the MTR for the tax bracket below the kink and τ_1 is the MTR for the tax bracket above it.

2014)[6]. Second, I assume that bunchers are homogeneous around the kink such that the elasticity is constant and unique in the area around the cutoff. Third, in line with the bunching literature, I expect to find diffuse bunching - commonly known as asymmetric bunching - rather than a clear spike at the kink due to adjustment costs, optimization frictions, imperfect forecast of income and incomplete information about the exact kink location (see Dekker *et al.* 2016).

Saez (2010) relates the amount of bunching generated by the introduction of the kink to the compensated taxable income elasticity. Let's take the buncher with the highest ability $n + \Delta n$ with an income $z^* + dz^*$ before the kink. The indifference curve of this individual is tangent to the linear budget constraint with slope $1 - \tau_0$. After the introduction of the kink this buncher reduces its income towards z^*. As a result, her new indifference curve is tangent to the non-linear budget constraint with slope $1 - \tau_1$ (see Fig. A.1). According to Kleven (2016), this buncher satisfies two tangency conditions: $z^* = (n + \Delta n)(1 - \tau_1)^e$ and $z^* + \Delta z^* = (n + \Delta n)(1 - \tau_0)^e$. The former refers to actual income (with the kink) and the latter refers to the counterfactual income (what the income would have looked like in the absence of the kink). By simple replacement of these two tangency conditions, I get:

$$\frac{\Delta z^*}{z^*} = \left(\frac{(1-\tau_0)}{(1-\tau_1)}\right)^e - 1 \qquad (1)$$

Eq. (1) "measures to what extent taxpayers respond to marginal incentives" (Kiss and Mosberger 2015, p. 886). In other words, to what extent they generate less taxable income when the MTR increases in 1%[7].

2.2.2 Empirical methodology

In the seminal study of Saez (2010) the author relates the income response Δz^* from Eq. (1) to the amount of bunching B as follows:

$$B = \int_{z^*}^{z^*+\Delta z^*} h_0(z).\partial z \simeq h_0(\xi)\Delta z^* \qquad (2)$$

[6] Using a similar dataset, Arrazola *et al.* (2014) and Sanz-Sanz *et al.* (2015) found that income effects in Spain are not significantly different from zero.

[7] Note that the elasticity is with respect to the net-of-tax rate because "taxpayers increase their income until the marginal utility of the last dollar earned less the MTR paid on this last dollar is equal to the marginal cost that is spent to earn this last dollar" (Saez 1999, p.5).

For doing so, Saez (2010) uses the mean value theorem of integration and some $\xi \in [z^*, z^* + \Delta z^*]$. Then, by simple replacement of Eq. (2) into Eq. (1) he gets: $e(z^*) = \frac{B}{z^* \times h_0(\xi) \times log\left(\frac{1-\tau_0}{1-\tau_1}\right)}$.

For a small tax change ($\Delta\tau = \partial\tau$ and $\Delta z = \partial z$), $\xi \to z^*$ and the number of individuals who bunch is $B = h_0(z^*)\Delta z^*$. Thus, the compensated elasticity is:

$$\lim_{\Delta\tau, \Delta z \to 0} \hat{e}(z^*) = e(z^*) = \frac{B}{z^* \times h_0(z^*) \times log\left(\frac{1-\tau_0}{1-\tau_1}\right)} \tag{3}$$

Note that the kink point z^* and the net-of-tax ratio associated to the kink $log\left(\frac{1-\tau_0}{1-\tau_1}\right)$ are known; whereas the excess mass B at z^* and the counterfactual density at the kink $h_0(z^*)$ need to be estimated.

The excess mass is estimated by comparing the empirical income distribution (with an excess mass around the kink) with respect to a counterfactual distribution (a hypothetical scenario absent of the kink). Saez (2010) constructs the counterfactual distribution using the empirical (observed) income distribution around the kink. For doing so, the author defines an income band around the kink $(z^* - \delta, z^* + \delta)$, and two surrounding income bands $(z^* - 2\delta, z^* - \delta)$ and $(z^* + \delta, z^* + 2\delta)$. The parameter δ measures the width of those income bands and is selected visually to ensure that $(z^* - \delta, z^* + \delta)$ covers the whole excess mass. Then, Saez (2010) estimates the excess mass by comparing the number of individuals in the band around the kink with respect to the number of individuals in the two surrounding bands as follows:

$$B = \int_{z^*-\delta}^{z^*+\delta} h(z)\partial z - \int_{z^*-2\delta}^{z^*-\delta} h(z)\partial z - \int_{z^*+\delta}^{z^*+2\delta} h(z)\partial z \tag{4}$$

Furthermore, to get the number of individuals in each band denoted as $\widehat{H}^*, \widehat{H}_+^*, \widehat{H}_-^*$ Saez (2010) regresses simultaneously a dummy variable for belonging to each band on a constant in the sample of individuals belonging to any of those three bands. Then, he estimates $\hat{h}(z^*)_- = \frac{\widehat{H}_-^*}{\delta}$, $\hat{h}(z^*)_+ = \frac{\widehat{H}_+^*}{\delta}$ and finally, he computes the empirical bunching parameter $\widehat{B} = \widehat{H}^* - \widehat{H}_+^* - \widehat{H}_-^*$ and the elasticity $\hat{e}$. Standard errors are then calculated using the delta method (alternatively, the bootstrap method).

To conclude this section, three observations are worth pointing out. First, since the elasticity is not determined at $z^* = 0$, I define z^* as average base income for tax filers with taxable income in $(z^* - 2\delta, z^* + 2\delta)$[8]. Second, for the cases of interior bunching I identify the amount where they are placed by visual detection, those amounts represent an approximation of where the interior bunching is. Ultimately, estimates are sensitive to the choice of the width parameter, if δ is too small (large), the excess mass might be under- (over-) estimated. I will go back to this in the next section.

2.3 Institutional setting and data

2.3.1 Personal income tax in Spain

Since 1991 the Spanish PIT is fully individualized. The tax unit, the individual, has the option to declare separately or jointly, this last in case of married couples, non-married cohabiting couples or single taxpayers with an under-age child or with a disable person[9]. This option of joint filing is mostly chosen by tax units with one bread-winner in the household, or in the case of two or more earners with incomes substantially different (Arrazola *et al.* 2014).

The Spanish PIT is a dual income tax system with two tax bases. The *general tax base* which include: labor, economic activities, movable capital (derived from intellectual and industrial property, technical assistance, renting of movable property, businesses or mines, subletting and leasing image rights), immovable capital, capital gains (not derived from the transfer of assets), income from special regimes and imputed income. The *savings tax base* which include: movable capital (derived from dividends, interest, income from insurance and capitalization operations) and capital gains (derived from transmissions and reimbursements of assets). Both tax bases are taxed at progressive rates that jump up at certain thresholds creating kinks in the tax schedule (see Table 2.1). For a matter of tractability, along this study I focus on the general tax base[10].

[8] I do the same to estimate bunching at the 1st tax kink in the base income distribution. But, to estimate bunching at the 1st tax kink in the gross income distribution, I take the average gross income for tax filers with gross income in $(z^* - 2\delta, z^* + 2\delta)$, as there is no broader income variable.

[9] The last day for taxpayers to present their PIT returns to the tax administration is June 30th $(\text{year} + 1)$. Thus, fiscal year (τ) is from January 1st to December 31st.

[10] Nevertheless, I am aware of the possibility of income shifting between tax bases. In a simultaneous analysis for savings taxable income I find bunching at the 2nd and 3rd tax kinks for married self-employed individuals with zero and one child (see Fig. E.1, Panel A). It is furthermore worth noting that taxpayers can transfer capital losses from current year to the next 4 years. This transfer - possible in both tax bases – reduce current base income as capital losses from year t are compensated with capital gains from year $t + 1$, $t + 2, t + 3$ and $t + 4$. As intra-(inter-) income shifting is not the perspective taken in this study I do not go deeper on this road. For the importance of these types of responses see Le Maire and Schjerning (2013), and Harju and Matikka (2014).

Another particularity of the Spanish PIT is that central and regional governments (ACs) can legislate over their PIT schedule, ACs have 50% of capacity over MTRs, deductions and tax bases. For this reason, the MTR, taken is a combination of the tax rates set by both governments, although in some cases I take a 'global' MTR that is a generalization for all ACs. For a better understanding of the MTRs used, Table 2.1 provides the 'global' MTR and Table A.1 sets the specific MTR applied in each AC. The tax schedule for the general taxable income consists of six tax brackets (seven after the tax reform of 2011) with increasing MTRs that create seven tax kinks; however, I focus on the first four because is where bunching is the clearest, and MTRs and tax bases are homogeneous among ACs[11].

Table 2.1: 2011 Tax Reform

National			
Taxable income (general base)		Marginal tax rates (%)	
Brackets	Nominal thresholds	2011	2012-2014
1	0	0.24	0.2475
2	17 707	0.28	0.30
3	33 007	0.37	0.40
4	53 407	0.43	0.47
5	120 000	0.45	0.50
6	175 000	0.47	0.53
7	300 000	0.47	0.54
Taxable income (savings base)		Marginal tax rates (%)	
Brackets	Nominal thresholds	2011	2012-2014
1	0	0.19	0.21
2	6 000	0.21	0.25
3	24 000	0.21	0.27

The Spanish PIT experimented a considerable modification with the Royal Decree-Law 20/2011 which was approved in Dec. 2011 and was implemented in Jan. 2012[12]. The application of the Royal Decree-Law 20/2011 raised MTRs substantially in both tax bases as can be seen in Table 2.1. It was considered the major increment on MTRs since PIT's implementation in 1978. In the general tax base this tax reform supposed an increase in the MTR of 0.75 percentage points in the 1st tax bracket and a large jump of 7 percentage points at the top. In the savings tax base, the rise was of 2 percentage points in the 1st tax bracket and 6 percentage points in the highest.

[11] Consequently, the range I use is $[-5\,000; 80\,000]$. Note that the general taxable income can be negative; for this reason, apart from One-parent households all histograms have no missing density just below zero.

[12] The goal of this tax modification was to reduce public deficits and mobilize domestic revenue; thus, no public announcement was previously done.

An overview of the components of the general taxable income (TIG) is given in Table 2.2[13]. Gross income is the sum of all sources of reported income: labor, immovable capital, movable capital, economic activities, capital gains, income from special regimes and imputed income. Base income is the sum of all net income (gross income minus standard deductions) and taxable income is defined as base income less itemized deductions.

Table 2.2: TIG components

Gross income
(-) Standard deduction to labor
(-) Standard deduction to capital
(-) Standard deduction to economic activities
(-) Standard deduction to imputed income
Base income = Gross income - Standard deductions
(-) Itemized deduction for joint declaration
(-) Itemized deduction for pension contributions
(-) Itemized deduction for pension contributions of the spouse
(-) Itemized deduction for pension contributions of the spouse constituted in favor of persons with disabilities
(-) Itemized deduction for contributions to protected assets of persons with disabilities
(-) Itemized deduction for compensatory pensions and alimonies
(-) Itemized deduction for fees to political parties
(-) Itemized deduction for pension contributions of athletes
Taxable income = Base income - Itemized deductions

To sum up, the Spanish tax system can evoke bunching behavior due to the combination of four factors. First, the progressive nature of the PIT creates discrete jumps of MTRs at bracket cutoffs. Second, joint tax filing for couples rises the possibility of income shifting between partners. Third, the exogenous increment on MTRs in the tax reform of 2011 exacerbates the incentives for bunching around cutoffs. Fourth, the important number of deductions for pension contributions (especially among couples) create room for strategic behavior of taxpayers. As I will show, these specific features of the Spanish tax system result in substantial bunching mainly among married couples.

2.3.2 Data

I use tax return microdata for the period 2010-2014, collected and prepared by the Spanish Tax Administration and the Institute for Fiscal Studies[14]. It is an annual cross-section sample with

[13] Bear in mind that the tax process continuous and further deductions (for housing, investment, charitable giving, maternity, etc.) are applied until we arrive to the exact amount of tax payment.

[14] The advantage of this type of data is that reported income represents the exact amount of taxable income the individual is due and, hence measurement error is minimal.

sampling weights to reflect the distribution of income tax returns of all the population with an approximate number of 1 million annual observations that represent to approximately 19 million of taxpayers per year (see Table 2.3).

The data contains variables corresponding to all sources of income, deductions and demographic information which I exploit in the anatomy of responses (see Table A.2). I restrict the estimation sample as follows. Neither Navarre nor Basque Country are included, data contains information only from the so-called Common Regime ACs. As in Chetty *et al* (2011), I exclude individuals under 16 years old and above 65 years old in order to consider taxpayers at working age and non-pensioners. Finally, no adjustment (or indexation) for inflation is needed in the study as inflation was low in the period under study and the tax schedule was stable in all the period[15].

Table 2.3: Summary statistics (general tax base)

Year	Variable	Observations	Mean	Std. Dev.	Min	Max
2010	Gross income	19257032	22816	31618	-8233590	3.98e+07
	Base income		18821	31003	-8234023	3.99e+07
	Taxable income		17809	30564	-8234023	3.99e+07
2011	Gross income	19467623	22614	40063	-1.10e+07	9.62e+07
	Base income		18611	30644	-1.10e+07	2.77e+07
	Taxable income		17638	30209	-1.10e+07	2.77e+07
2012	Gross income	19379382	21878	31114	-1.72e+07	2.99e+07
	Base income		17916	30456	-1.72e+07	2.99e+07
	Taxable income		16978	30043	-1.72e+07	2.99e+07
2013	Gross income	19203031	21924	39429	-7.90e+07	6.28e+07
	Base income		17960	39044	-7.90e+07	6.29e+07
	Taxable income		17032	38704	-7.90e+07	6.27e+07
2014	Gross income	19358913	22050	40191	-9.61e+07	5.21e+07
	Base income		18064	39624	-9.61e+07	5.21e+07
	Taxable income		17141	39286	-9.61e+07	5.21e+07

2.3.3 Sample selection

Three types of disaggregation are done in the empirical analysis. First, based on previous studies for Spain, I observe that changes in MTRs have heterogeneous effects on different tax filers depending on their socio-economic characteristics. For this reason, I divide the whole sample in five socio-economic groups: non-married taxpayers with no child (One-household), non-married cohabiting couples and single taxpayers with a disable person or with an under-age child (One-

[15] CPI: 1% (2010), 3.3% (2011), 2% (2012), 2.7% (2013) and 0.2 (2014). Source: National Statistics Institute (INE).

parent), married taxpayers with no child (Married0), married taxpayers with one child (Married1) and married taxpayers with two or more children (Married2). Second, I disaggregate by demographic characteristics: gender (men, women), type of tax return (individual, joint) and main income source (wage earners, self-employed). I define wage earners as taxpayers whose main income source (MIS) is labor; that is, when their net income from labor is strictly higher than their net income from capital and their net income from economic activities[16]. Likewise, I define self-employed individuals as those whose MIS is economic activities; that is, when their net income from economic activities is strictly higher than their net income form capital and their net income from labor. The third type of disaggregation is by fiscal characteristics: deduction for joint declaration (Itemized_C) and deductions to pension contributions (Itemized_PP). The former refers to taxpayers who *only* use the deduction for joint declaration and the latter refers to taxpayers who use *any* itemized deductions, except the one for joint declaration. Note that I am pooling together all itemized deductions (except joint declaration) into the deduction to pension contributions because the majority of them refer to it and separately represent insignificant amounts (see Table 2.2).

Lastly, I make a selection of cases based on the following criteria. (i) Statistical significance[17]. (ii) Responsiveness, that is I select the AC in each socio-economic group with the clearest bunching evidence. (iii) Consistency, estimations must be consistent with what is visually detected[18]. (iv) Representativeness, I focus on the most representative ACs, although the analysis is over the 16 ACs (Ceuta and Melilla are pooled together).

Three final comments. First, the main drawback in this study is that I have no information available for gross income from economic activities neither for imputed income. To overcome this limitation, in the estimation of gross income I take the net income of those sources. Second, there are no observations below zero for One-parent. This is so, because individuals using the deduction for joint declaration only report positive taxable income and, by definition, One-parent taxpayers are those who make use of this deduction. Third, the ETI parameter can be negative because δ does not capture the whole bunching, or capture much more than it reducing (or increasing) the magnitude and the significance of the parameter. Negative elasticity might also reveal that taxpayers are not bunching exactly at the tax kink because of incomplete information, imperfect forecast, adjustment costs, optimization frictions or psychological components[19]. Finally, negative elasticity might be simply because I have a missing mass in the distribution (i.e. a hole). For all these reasons, the

[16] When I refer to capital I am not considering capital gains nor savings.

[17] I have exceptional cases which are cases with sharp bunching at tax kinks, but with $0.1 < \text{p.value} \leq 0.2$.

[18] Besides these criteria, for interior bunching I select the most notorious and repetitive cases.

[19] As a matter of fact, when I take the point where bunching is exactly placed - as in the case of interior bunching - I get no negative elasticity.

appropriate bandwidth is determined by graphical inspection being $\delta = (1\ 000€, 1\ 500€, 2\ 000€)$ the closer bandwidths to the true elasticity revealed by bunching behavior (Saez, 2010)[20].

2.4 Results

Bunching estimation is a genuinely visual technique (Bastani and Selin 2014). Accordingly, along this section I display graphs and estimate elasticities for the most responsive AC in each socio-economic group: Madrid (One-household), Catalonia (One-parent), Andalusia (Married0), Castile-La Mancha (Married1) and Valencia (Married2)[21]. For a matter of tractability, I show in each graph the type of bunching I identify: bunching (B), bunching-hole (BH), agglomeration (A), asymmetric bunching (AB), hole (H) and interior bunching (IntB)[22]. I begin by providing evidence for Spanish taxpayers bunching at tax kinks. I show that some of these cases are only due to the progressivity of the PIT, but others are also a consequence of the reform undertaken in 2011. I go on to identify who are the tax filers responsible of such bunching and the potential channels used to bunch at tax kinks.

2.4.1 Bunching evidence

Figure 2.1 reports the histogram of gross income (GIG) and taxable income (TIG) for the general tax base, in each socio-economic group. Dashed lines depict the corresponding MTR schedule for each AC (as a function of income) and vertical lines display the location of the kinks. The goal is not to compare between GIG and TIG, instead it is to show visual evidence of bunching.

Three elements are worth noting in Figure 2.1. First, there is a clear clustering of tax filers around the first four tax kink points in the gross income distribution (see Panels A-E). The reason for this may be the existence of optimization frictions such as inattention and misperception among Spanish taxpayers. Because of the complexity of the tax schedule taxpayers might confuse their TIG with their GIG and bunch exactly at tax kinks. This argument is related to the 'revenue complexity hypothesis' which suggest that the more complex the tax schedule, the more difficult it is for tax filers to know their tax liability (Sanandaji and Wallace 2010)[23].

[20] Exceptionally I also use $\delta = (500€, 2\ 500€)$.

[21] Results for the rest of ACs are available upon request.

[22] Note that when nothing is written on the graph is because nothing is visually detected. To identify bunching at the 4th tax kink I reduce the range of observations to the exact size of the tax bracket.

[23] Several studies quantify the effect of misperception on taxation. Among them, Chetty (2009) and Chetty *et al.* (2009) analyzed tax incidence and welfare with misperceiving agents. For Spain, for instance, Arrazola *et al.* (2000) found divergences between statutory and perceptive MTRs among working married men.

The second element identified in Figure 2.1 (Panels F-J) is the clear bunching at the first four tax kinks in the taxable income distribution. There is no bunching in the upper tax kinks because taxpayers in top tax brackets may misreport through other channels (not taken in the study) as savings, wealth and income shifting. Bunching at the first four tax kinks for taxable income confirm that taxpayers are responding to taxation. As stated in previous section, discrete jumps of MTRs at bracket cutoffs introduce an incentive to taxpayers for moving from a point above the cutoff to a point just below it by reducing taxable income through legal or illegal channels (Kleven 2016)[24]. For tractability, in this study I pooled all legal channels into two behavioral responses: real supply responses (changes in hours of work, effort, productivity, etc.) and compliance responses. For practical reasons, I classify compliance responses in legal tax avoidance responses (LTA) and legal tax reduction responses (LTR). The goal in both is to reduce taxable income, the difference is in the strategy used for doing so. In LTA responses, taxpayers take advantage of the legal gaps in the tax system to reduce their taxable income through the "retiming of transactions, shifting of income from one base to another, shuffling of financial transactions, and so on" (Slemrod 1998, p. 787). On the contrary, in LTR responses, taxpayers use the fiscal benefits that correspond to them and, in this way, they reduce their reported income.

Third, in Figure 2.1 (Panels A-J) bunching takes different forms as: bunching-hole, agglomeration, hole, asymmetric bunching or interior bunching. Three arguments in the empirical bunching literature can shed light on this result. (i) Agglomerations and asymmetric bunching are often due to the presence of adjustment costs, imperfect forecast of income and incomplete information about the exact kink location which impede taxpayers to bunch exactly at the kink[25]. (ii) Bunching-holes and holes are probably due to the unwillingness of potential bunchers to move to the left to fulfill the gap left by bunchers creating a hole just above the kink point[26]. (iii) Interior bunching is a more puzzling form of bunching. In trying to explain it, one could call upon the presence of psychological components. According to Dekker *et al.* (2016), risk-averse taxpayers are more likely to over-adjust their income to make sure they realize an income which is below the cutoff and, in consequence, they end up within the tax bracket[27].

[24] I am not considering illegal channels (i.e. tax evasion) in the analysis as I have no information about non-registered taxpayers.

[25] Another explanation for agglomerations and for asymmetric bunching is the 'rounding effect hypothesis': "taxpayers have a tendency to report taxable income in round numbers, which create mass points at round numbers in the empirical distribution" (Kleven and Waseem 2013, p. 693).

[26] Bunching-holes are similar to what Kleven and Waseem (2013) call notches. The difference is that bunching-holes are produced by discontinuities in the slope of the choice set; whereas, notches are produced by discontinuous jumps in tax liability at brackets cutoffs. Moreover, the difference between bunching-holes and asymmetric bunching is that the latter is not followed by a hole.

[27] Also, it is possible that the point where the interior bunching is placed is a natural focal point created by the central or the regional government when they legislate public policy. In the empirical bunching literature those points are known as 'reference-points' (Kleven 2016).

Finally, in respect to the sensitivity analysis, I expect to have larger elasticities with large bandwidths (Saez 2010); however, there are two reasons why this intuition is not necessarily true. First, when bunching takes the form of a bunching-hole, a hole, an asymmetric bunching or an agglomeration, the elasticity is likely to be non-significant[28]. Nevertheless, it must be stressed that in some cases there is a bandwidth that captures the bunching-hole, the hole, the asymmetric bunching or the agglomeration making the elasticity significant[29]. This is so, because the place where the bunching-hole, the hole, the asymmetric bunching or the agglomeration is located is not exactly at the cutoff[30]. Second, the width of bunching can be different in each case; therefore, if bunching is narrow (wide) a larger bandwidth will reduce (increase) the elasticity[31]. Consequently, the elasticity does not necessarily increase (on magnitude and significance) with the bandwidth. For this reason, the appropriate bandwidth varies its size depending on the observed bunching and is determined by graphical inspection[32].

All in all, this first result shows substantial evidence of bunching around the first four tax kink points of the PIT. Further interpretations have been risen to explain such bunching and its different forms. I will go back to some of them in the next sections, but first I need to distinguish if the detected bunching is only due to the progressivity of the PIT, or it can be also evidence of the 2011 tax reform.

[28] For instance, see in Table 2.4: Columns (1), (3), (4), (8), 2nd kink. Column (4), 3rd kink.

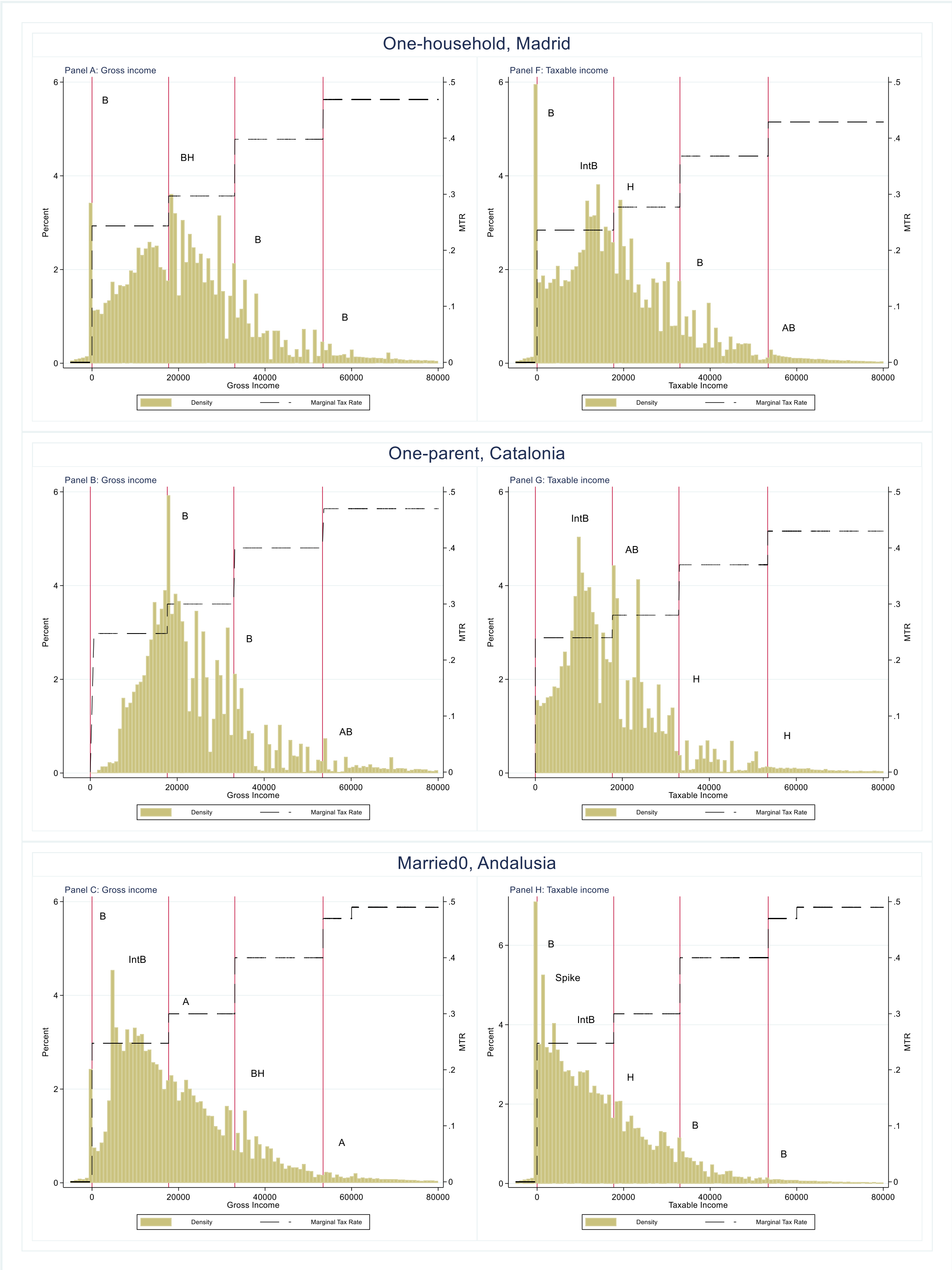
[29] For instance, see in Table 2.4: Columns (5) - (7), 2nd kink. Columns (5) and (7), 3rd kink. Columns (4), (6), (7), (9), 4th kink.

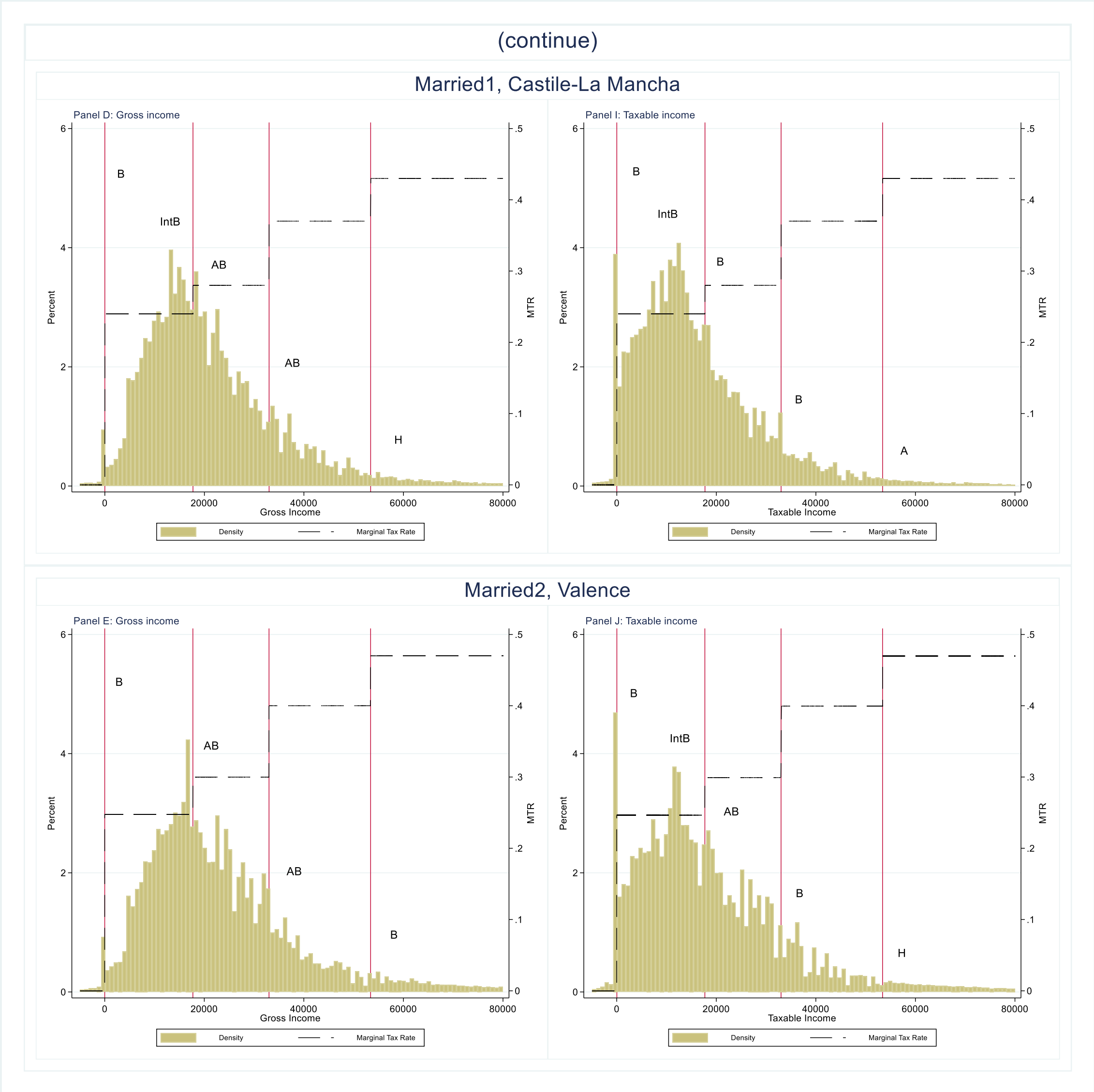
[30] Indeed, when I take the exact point where bunching is placed, large bandwidths give larger elasticities. This is the case of interior bunching, see columns (1) - (9), Table 2.4.

[31] For the case of a wide bunching, see in Table 2.4: Columns (2), (6), (10), 3rd kink. Columns (1) and (5), 4th kink. For the case of a narrow bunching, see in Table 2.4: Columns (1-10), 1st kink. Column (8), IntB.

[32] This method of trial-and-error is one of the main critiques to Saez (2010) methodology; however, few studies have proposed an alternative, Dekker *et al.* (2016) is one of them.

Figure 2.1: Bunching evidence





Notes: Figure 2.1 displays the histogram of gross income (left) and taxable income (right) for the most responsive AC in each socio-economic group. Gross income is defined as the sum of all sources of income (labor, economic activities, capital and imputed income) and taxable income is defined as base income minus itemized deductions, I do not consider savings. Histograms are computed using sample weights and for a given year over 2010-2014. The MTR schedule is displayed by the dashed line and corresponds to the AC under study. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in all ACs: 0€, 17 707€, 33 007€ and 53 407€. Bins 100€. Interior bunching for taxable income: One-household (12 500€), One-parent (10 000€), Married0 (4 000€), Married1 (12 500€), Married2 (11 600€) and for gross income: Married0 (4 800€) and Married1 (13 500€).

Table 2.4: Income elasticity estimates using bunching evidence

Kink	Bandwidth	Gross income					Taxable income				
		One-household Madrid	One-parent Catalonia	Married0 Andalusia	Married1 CM	Married2 Valence	One-household Madrid	One-parent Catalonia	Married0 Andalusia	Married1 CM	Married2 Valence
		(1)	(2)[b]	(3)	(4)	(5)	(6)	(7)[b]	(8)	(9)	(10)
Panel A: Estimates around kinks and interior points											
1st	1 500 €	14.85***	-	13.65***	10.11***	10.64***	17.61***	-	12.71***	7.10***	9.76***
		(0.17)	-	(0.27)	(0.75)	(0.35)	(0.21)	-	(0.24)	(0.63)	(0.26)
2nd	1 500 €	0.11	0.44*	0.09	0.01	0.46**	0.15	2.28***	-0.06	0.63*	0.37[a]
		(0.23)	(0.26)	(0.12)	(0.19)	(0.19)	(0.35)	(0.76)	(0.15)	(0.32)	(0.25)
3rd	1 500 €	0.03	0.19	-0.07*	0.06	0.19**	0.04	-0.28***	0.04	0.24*	-0.20***
		(0.08)	(0.16)	(0.04)	(0.09)	(0.09)	(0.08)	(0.10)	(0.06)	(0.13)	(0.05)
4th	1 500 €	-0.05*	2.92***	0.19***	-0.09	-0.11***	0.07***	-0.22***	-0.05***	0.09*	-0.10***
		(0.03)	(1.19)	(0.05)	(0.07)	(0.03)	(0.02)	(0.03)	(0.02)	(0.05)	(0.01)
IntB[c]	1 500 €	-	-	0.50***	0.1**	-	1.11***	1.37***	-0.28***	1.13***	1.50***
		-	-	(0.02)	(0.04)	-	(0.37)	(0.53)	(0.06)	(0.42)	(0.34)
Panel B: Sensitivity analysis with bandwidth											
1st	1 000 €	16.58***	-	16.51***	14.31***	12.49***	19.16***	-	7.81***	7.99***	10.19***
		(0.19)	-	(0.28)	(0.60)	(0.36)	(0.24)	-	(0.36)	(0.55)	(0.25)
2nd	1 000 €	0.18	0.40	0.09	0.14	-0.1	-0.64***	0.81	-0.02	-0.09	-0.04
		(0.21)	(0.26)	(0.11)	(0.18)	(0.13)	(0.19)	(0.51)	(0.13)	(0.21)	(0.18)
3rd	1 000 €	0.31**	(-) 0.14**	-0.13***	-0.04	-0.01	0.07	-0.28***	0.16**	0.15	0.00
		(0.13)	(0.06)	(0.03)	(0.06)	(0.05)	(0.07)	(0.06)	(0.06)	(0.10)	(0.06)
4th	1 000 €	0.01	0.60**	0.05	-0.10*	-0.05*	0.14***	0.07*	0.05***	0.02	-0.09***
		(0.03)	(0.31)	(0.03)	(0.05)	(0.03)	(0.02)	(0.04)	(0.02)	(0.04)	(0.01)
IntB[c]	1 000 €	-	-	0.33***	0.06*	-	0.31	0.78*	0.41***	0.26	0.62***
		-	-	(0.02)	(0.03)	-	(0.32)	(0.40)	(0.07)	(0.30)	(0.24)
1st	2 000 €	12.87***	-	8.27***	2.05***	5.87***	16.20***	-	12.10***	3.51***	8.15***
		(0.17)	-	(0.44)	(0.74)	(0.57)	(0.22)	-	(0.25)	(0.41)	(0.41)
2nd	2 000 €	0.03	0.43	-0.03	0.25	0.70***	0.122	2.81***	0.20	0.27	0.08
		(0.25)	(0.29)	(0.13)	(0.23)	(0.22)	(0.39)	(0.86)	(0.19)	(0.32)	(0.25)
3rd	2 000 €	-0.13	0.51**	0.02	0.07	0.16*	-0.17**	0.03	-0.05	0.08	-0.22***
		(0.08)	(0.24)	(0.06)	(0.11)	(0.09)	(0.07)	(0.19)	(0.06)	(0.12)	(0.06)
4th	2 000 €	0.39***	0.30	-0.01	-0.06	0.14**	0.01	-0.28***	-0.1	-0.08*	0.02
		(0.06)	(0.19)	(0.04)	(0.09)	(0.06)	(0.02)	(0.03)	(0.02)	(0.04)	(0.02)
IntB[c]	2 000 €	-	-	0.62***	0.11**	-	1.39***	2.65***	-1.86***	2.06***	0.97***
		-	-	(0.03)	(0.04)	-	(0.42)	(0.68)	(0.05)	(0.51)	(0.32)

Notes: Table 2.4 shows the elasticity estimates for the B, BH, A, H, AB and IntB detected in Fig. 2.1. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** $p<0.01$, ** $p<0.05$, * $p<0.1$.

[a] This is an exceptional case with sharp AB at the kink, but p-value of 0.145.

[b] Since there is no observation below zero for One-parent, no bunching at the 1st tax kink is detected.

[c] (-) means no interior bunching is visually detected in the income distribution.

2.4.2 Dynamics of bunching

The key insight of the bunching approach is that discontinuities in the budget set of individuals induce them to reduce their taxable income and cluster at tax kinks. Therefore, any progressive tax - as the Spanish PIT - give rise to kinks and bunching around them. However, the tax has the additional peculiarity of having implemented a tax reform in 2011 in which all MTRs were severely raised making discontinues changes in marginal tax incentives more marked (see Table 2.1)[33]. At first glance, in Fig. A.2 the number of taxpayers and the amount of taxable income decrease most in 2012 with respect to 2011. This drop is detected in all socio-economic groups and all tax brackets, but more substantially in the 3rd and 4th tax brackets. This first overlook suggests that Spanish taxpayers did not accept the reform passively; on the contrary, they reacted by modifying their reported income. This hypothesis rests on three main findings.

First, Figure 2.2 (Panels E and F) and Figure B.1 (Panels A and B) show bunching and interior bunching in the post-reform income distribution that are inexistent in the pre-reform distribution[34]. Empirically, the elasticities are either negative, non-significant or inexistent in the pre-reform year, and positive and significant in the post-reform year[35]. Second, bunching is more centered at the kink in the post-reform year. For instance, in Figure 2.2 (Panels C and D) and Figure B.1 (Panels C and D) there is a bunching-hole and an asymmetric bunching in the pre-reform year that becomes a bunching in the post-reform year. For these cases, the elasticity is negative and/or non-significant in the pre-reform year, and positive and significant in the post-reform year[36]. Third, bunching at the 1st tax kink and interior bunching are more pronounced in the post-reform year than in the pre-reform year[37]. Empirically, the elasticity is higher in magnitude and significance in the post-reform year than in the pre-reform year[38].

All in all, these three findings confirm the impact of the tax reform on individuals' behavior. Interestingly, when I analyze deeply the characteristics of the tax reform effect by gender and by

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[33] I select the best AC to show the effect of the tax reform in each socio-economic group. However, for Madrid (One-household), Catalonia (One-parent) and Castile-La Mancha (Married1) I find evidence of the PIT's progressivity but not of the tax reform. Therefore, I select the second-best AC to display evidence of the tax reform in those socio-economic groups.

[34] There is a spike at 1 500€ in the post-reform income distribution of Married0, which is not taken as interior bunching because it is captured in the bunching window of the 1st tax kink. It must be taken with caution as it can over-estimate the ETI of the 1st tax kink.

[35] See: Panel C, 2nd-4th kinks and IntB, Table 2.5. Panel A, 3rd-4th kinks, IntB, Table B.1.

[36] See: Panel B, 2nd-4th kinks, Table 2.5. Panel B, 4th kink, Table B.1.

[37] For bunching at the 1st kink: Figure 2.2 (all panels, except C and D) and Figure B.1 (Panels C and D). For interior bunching: Figure 2.2 (Panels C, D, G and H).

[38] See: All panels (except Panel B), 1st kink, Table 2.5. Panel B, 1st kink, Table B.1. Panel B, IntB, Table 2.5.

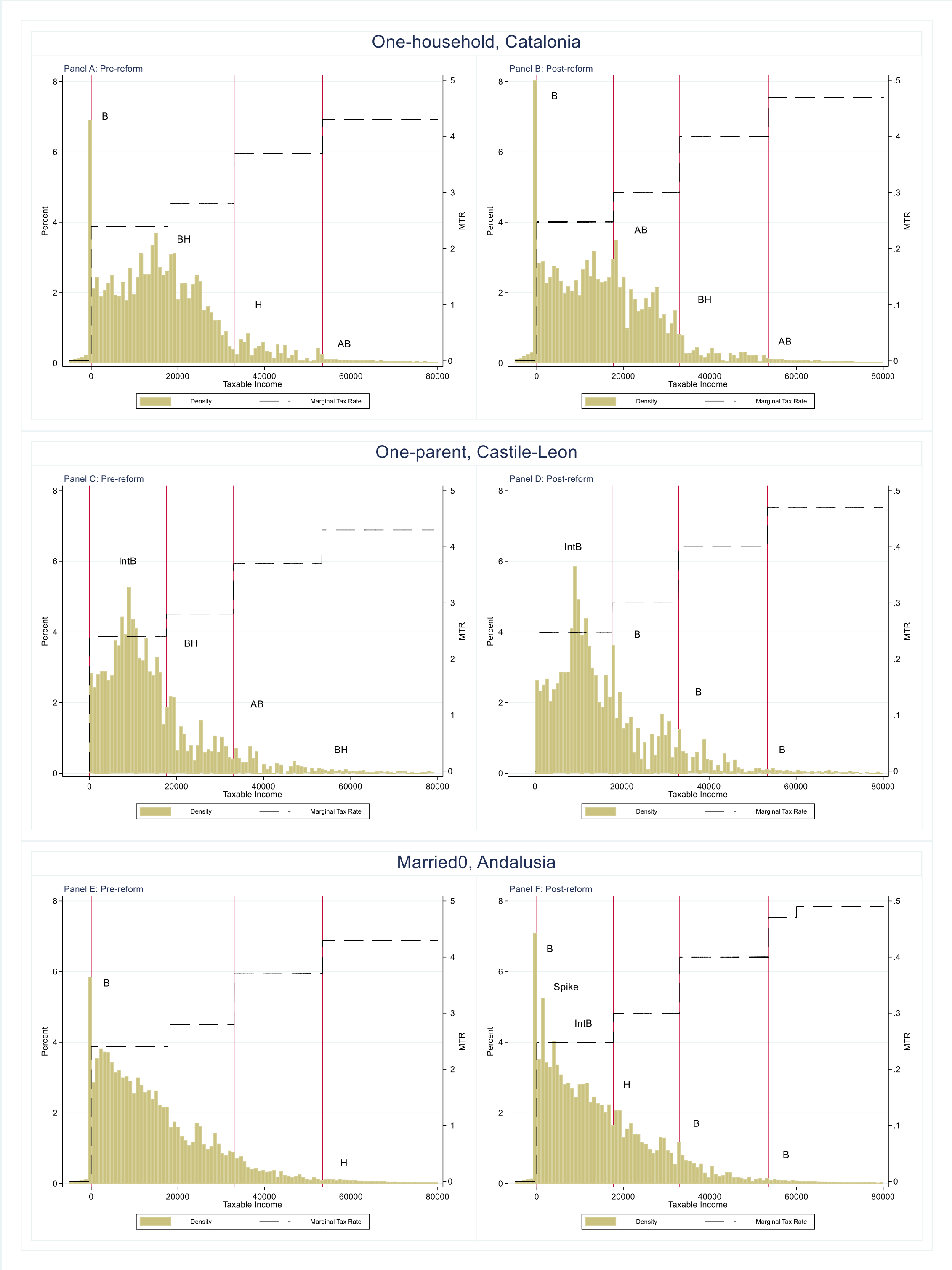
MIS, I see this effect is especially pronounced for Married0, for women and for wage earners[39] (see Fig. B.1 and Table B.1). This result indicates that these groups are more sensitive to tax changes and consequently react more to the tax reform, I will go back to this intuition in the next subsection.

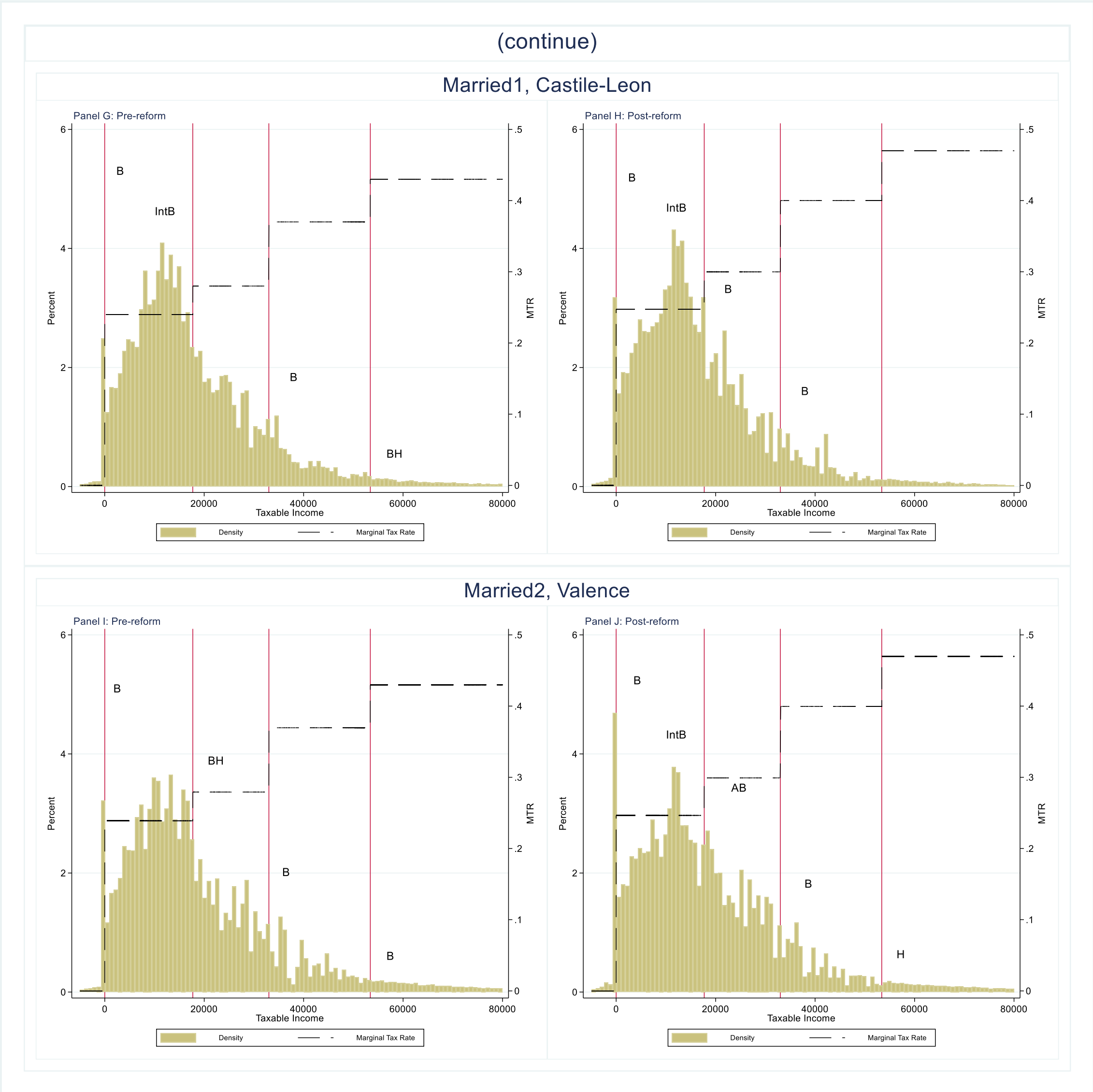
On the whole, there is evidence in favor that the tax reform undertaken in 2011 had an impact on individuals' behavior. Moreover, the speed of reaction provides supporting evidence that behavioral changes are driven by compliance responses rather than real responses since it is difficult to adjust real supply responses in a short period, because of adjustment costs and optimization frictions, e.g. existing long-term contracts[40].

[39] The economic crisis might have made the Spanish labor market more flexible (with more temporal contracts, easing firings, etc.) which in turn might have made feasible real supply responses than in other years of more rigidity. In addition, the economic crisis may have had an effect on the extensive margin, rising unemployment and informal labor. Nevertheless, those effects are out of our scope of analysis, although I am aware of the potential influence of the real business cycle on the results.

[40] A similar reasoning is followed by Kleven and Waseem (2013), Saez (1999), Mosberger (2016) and Lediga *et al.* (2016).

Figure 2.2: Dynamics of bunching





Notes: Figure 2.2 displays the histogram of taxable income for the best AC to show the effect of the tax reform in each socio-economic group. Taxable income is defined as base income minus itemized deductions and is the same in both years. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year before and after the reform. The MTR schedule is displayed by the dashed line and corresponds to each year (taking into account the tax reform) for the correspondent AC. The first four tax kink points are displayed by the vertical lines on the graph and are the same in both years: 0€, 17 707€, 33 007€ and 53 407€. Bins 100€. Interior bunching: One-parent (9 200€) in both years, Married0 (4 000€) in the post-reform year, Married1 (12 500€) in both years and Married2 (11 600€) in the post-reform year.

Table 2.5: Elasticity of taxable income, dynamics of bunching

Kink	Bandwidth [c]	Pre-reform year (1)	Post-reform year (2)
Panel A: One-household, Catalonia			
1st	2 500 €	13.47***	13.57***
		(0.19)	(0.14)
2nd	1 500 €	-0.04	0.85***
		(0.21)	(0.24)
3rd	1 500 €	-0.42***	0.28***
		(0.03)	(0.08)
4th	1 500 €	0.94***	0.07***
		(0.05)	(0.02)
IntB	1 500 €	-	-
		-	-
Panel B: One-parent, Castile-Leon			
1st	1 500 €	-	-
		-	-
2nd	1 500 €	-0.79**	1.10*
		(0.39)	(0.60)
3rd	2 000 €	-0.23[a]	0.22
		(0.17)	(0.27)
4th	2 000 €	0.01	0.28*
		(0.13)	(0.16)
IntB	1 500 €	0.86*	1.92***
		(0.50)	(0.56)
Panel C: Married0, Andalusia			
1st	1 500 €	8.69***	12.71***
		(0.38)	(0.24)
2nd	500	0.02	-0.21***
		(0.12)	(0.07)
3rd	1 000 €	-0.08**	0.16**
		(0.04)	(0.06)
4th	1 000 €	-0.12***	0.05***
		(0.01)	(0.02)
IntB	1 000 €	-	0.41***
		-	(0.07)
Panel D: Married1, Castile-Leon			
1st	1 500 €	4.52***	7.21***
		(0.47)	(0.49)
2nd	500	-0.08	0.28**
		(0.12)	(0.13)
3rd	1 500 €	0.11	-0.08
		(0.08)	(0.06)
4th	1 500 €	0.04	-0.05**
		(0.04)	(0.03)
IntB	1 500 €	0.52**	0.78***
		(0.23)	(0.19)

Panel E: Married2, Valence			
1st	1 500 €	5.91***	9.76***
		(0.49)	(0.26)
2nd	1 500 €	-0.03	0.37[b]
		(0.27)	(0.25)
3rd	1 500 €	-0.10	-0.20***
		(0.07)	(0.05)
4th	1 500 €	0.01	-0.10***
		(0.02)	(0.01)
IntB	1 500 €	-	1.50***
		-	(0.34)

Notes: Table 2.5 shows the elasticity estimates for the B, BH, A, H, AB and IntB detected in the pre- and post-reform year in Fig. 2.2. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] This is an exceptional case with sharp AB at the kink, but p-value of 0.17.
[b] This is an exceptional case with sharp AB at the kink, but p-value of 0.15.
[c] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.
[d] (-) means no interior bunching is visually detected in the income distribution.

2.4.3 Who are the bunchers?

To answer this question, in Figures 2.3 – 2.5 I break down the sample of Married0 (Andalusia) and Married1 (Castile-La Mancha) by gender, by type of tax return and by MIS[41]. Then, I observe if the bunching identified in the overall sample remains in one of the subgroups. If that is the case, then that subgroup is a buncher. In short, bunchers are the tax filers responsible of the observed bunching in the overall sample[42]. Empirically, in Table 2.6 I compare the sign, the significance and the magnitude of the elasticity between subgroups to verify what is visually detected[43]. Additionally, in Table 2.7 I run a Probit regression to confirm who bunch at the 1st tax kink.

I find that bunchers are: married couples, women (in Married0), men (in Married1), wage earners and taxpayers filing their tax return individually. One explanation for married couples being more responsive to taxation is because being married in the Spanish PIT schedule gives additional fiscal benefits and hence, more room for LTR responses. For instance, the option of joint tax filing and two additional deductions related to pension contributions that only married couples can use (i.e. itemized deduction for pension contribution of the spouse and itemized deduction for pension contribution of the spouse constituted in favor of persons with disabilities, see Table 2.2).

Figure 2.3 (Married0) shows that women are responsible of interior bunching and bunching at 1st-4th tax kinks. On the contrary, Figure 2.3 (Married1) shows that men are responsible of interior bunching and bunching at the 4th tax kink. Both results are confirmed in Table 2.6 (columns (2) and (3)) as elasticities are higher in significance and magnitude for women (in Married0) and men (in Married1). Women being more sensitive to taxation than men is a result commonly explained in the bunching literature with the argument that, among married couples, women are more likely to be second or part-time earners and men, the breadwinner of the household. The insight behind this argument is that second or part-time earners usually have more flexibility in hours' choice and earnings decisions (Saez 2010). In trying to explain why men are more responsive than women for married couples with one child, I find differences by gender for married taxpayers, not detected for non-married taxpayers. To be more precise, I find that, among non-married taxpayers, men and

[41] I focus the analysis on these two socio-economic groups because when I divide One-household and One-parent by demographic characteristics, distributions become too noisy making difficult the identification of bunching. In addition, differences between subgroups are more notorious in Married0 and the results obtained for Married1 are the same for Married2. Therefore, findings for Married1 can be generalized to Married2. The figures for the rest of socio-economic groups are available upon request.

[42] Subgroups with more observations are more likely to have a similar distribution as the overall sample. However, this does not ensure them to be bunchers. As mentioned above, bunchers are the subgroups who have the same (or similar) bunching detected in the overall sample.

[43] Bear in mind that the estimates of the subgroups do not need to sum the estimate of the overall sample. I only care about the sign, the significance and the magnitude.

women are equally responsive but among married couples I observe clear differences between them. In addition, I find that women with no child are more responsive to taxation than women with one, two or more children. This suggests that the number of children may be influencing women reporting behavior; in other words, having one or more children make women less sensitive to taxation.

Furthermore, in Figure 2.4 taxpayers who report individually are responsible of interior bunching and bunching at the 2nd-4th tax kinks. This result is supported empirically in Table 2.6 (columns (4) and (5)). This is so probably because tax filers reporting individually have a higher income level, compared to those reporting jointly. Contrarily to many other studies, I find that wage earners are responsible of interior bunching and bunching at the 2nd-4th tax kinks (see Figure 2.5 and Table 2.6, columns (6) and (7))[44]. The most plausible explanation is the use of tax deductions among this subgroup, as I will show in the next section. Nevertheless, other explanations relate this fact to institutional features as the existence of collusion between the employer and the employee, and bargaining channels (see Bastani and Selin 2014; Dekker *et al.* 2016; Piketty *et al.* 2013).

Finally, I find that bunching at the 1st tax kink is driven by women, taxpayers reporting jointly and self-employed individuals. As can be seen in Figures 2.3 – 2.5, bunching at the 1st tax kink is steeper for these taxpayers than for men, taxpayers reporting individually and wage earners. This is precisely what is observed in Table 2.6 (Panels A and B) and Table 2.7. The Probit regression confirms that it is more likely for women, taxpayers reporting jointly and self-employed individuals (as well as capital owners) to bunch at the 1st tax kink. Women and taxpayers reporting jointly are usually individuals with low income, second or part-time earners who do not depend much on their income and hence, are less constraint to adjust their taxable income (Dekker *et al.* 2016)[45]. However, this argument does not seem realistic for self-employed individuals. One possible explanation why these individuals bunch at the 1st tax kink is that they might have other sources of income, as savings. Figure E.1 (Panel A) confirms this hypothesis, I detect bunching at the 2nd and 3rd tax kinks of the savings taxable income distribution only for the self-employed in Married0 and Married1 (no bunching is detected for wage earners neither for One-household, One-parent and Married2).

To conclude this section, two main findings are worth pointing out. First, interior bunching and bunching at the 2nd-4th tax kinks are mainly driven by women (in Married0), men (in Married1), taxpayers reporting individually and wage earners. Second, women, taxpayers reporting jointly and

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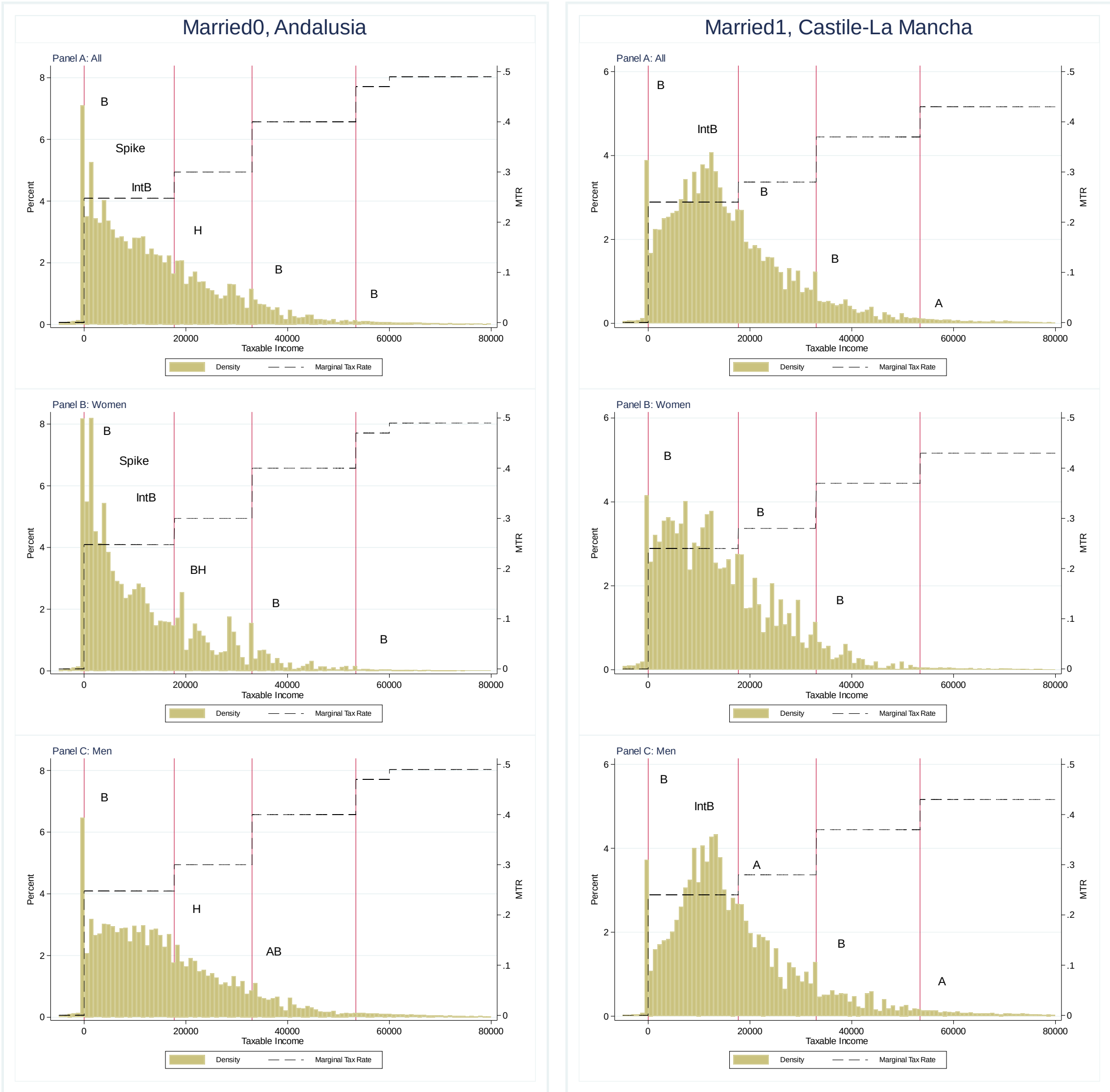
[44] In the broad literature self-employed individuals are commonly the most responsive taxpayers due to their greater possibilities of adjusting their taxable income, the lack of third-party reporting and their low tax moral (Kleven *et al.* 2011; Chetty 2012).

[45] Sharp bunching at the 1st tax kink is also explained by the fact that in a complex tax system, the 1st tax kink point "is more salient and easier to understand than other kink points" (Saez 2010, p. 211).

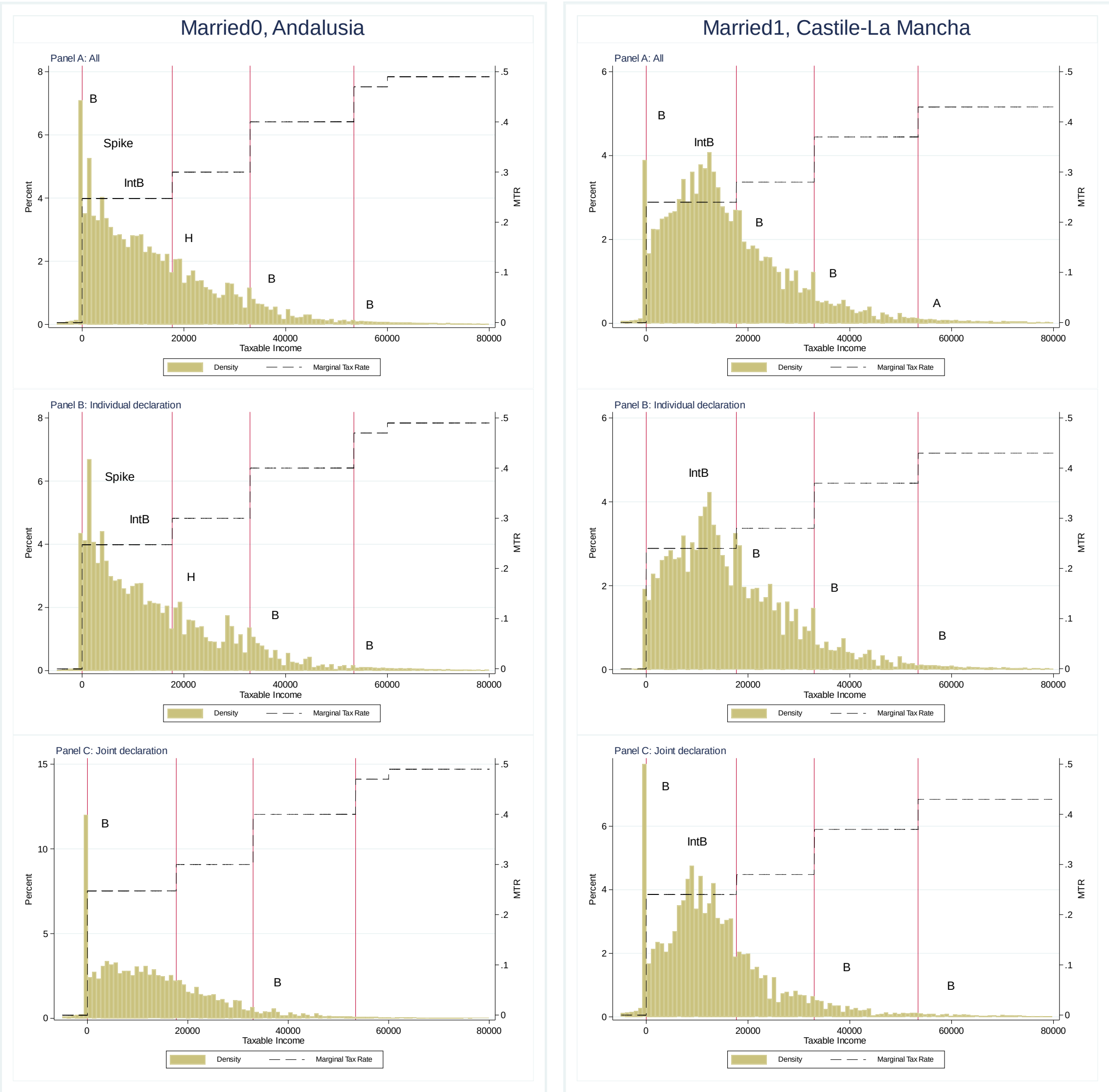
self-employed individuals are responsible of bunching at the 1st tax kink. These two findings are confirmed at an aggregate level (see Figures C.1-C.3 and Tables C.1-C.2).

Figure 2.3: Bunchers, by gender



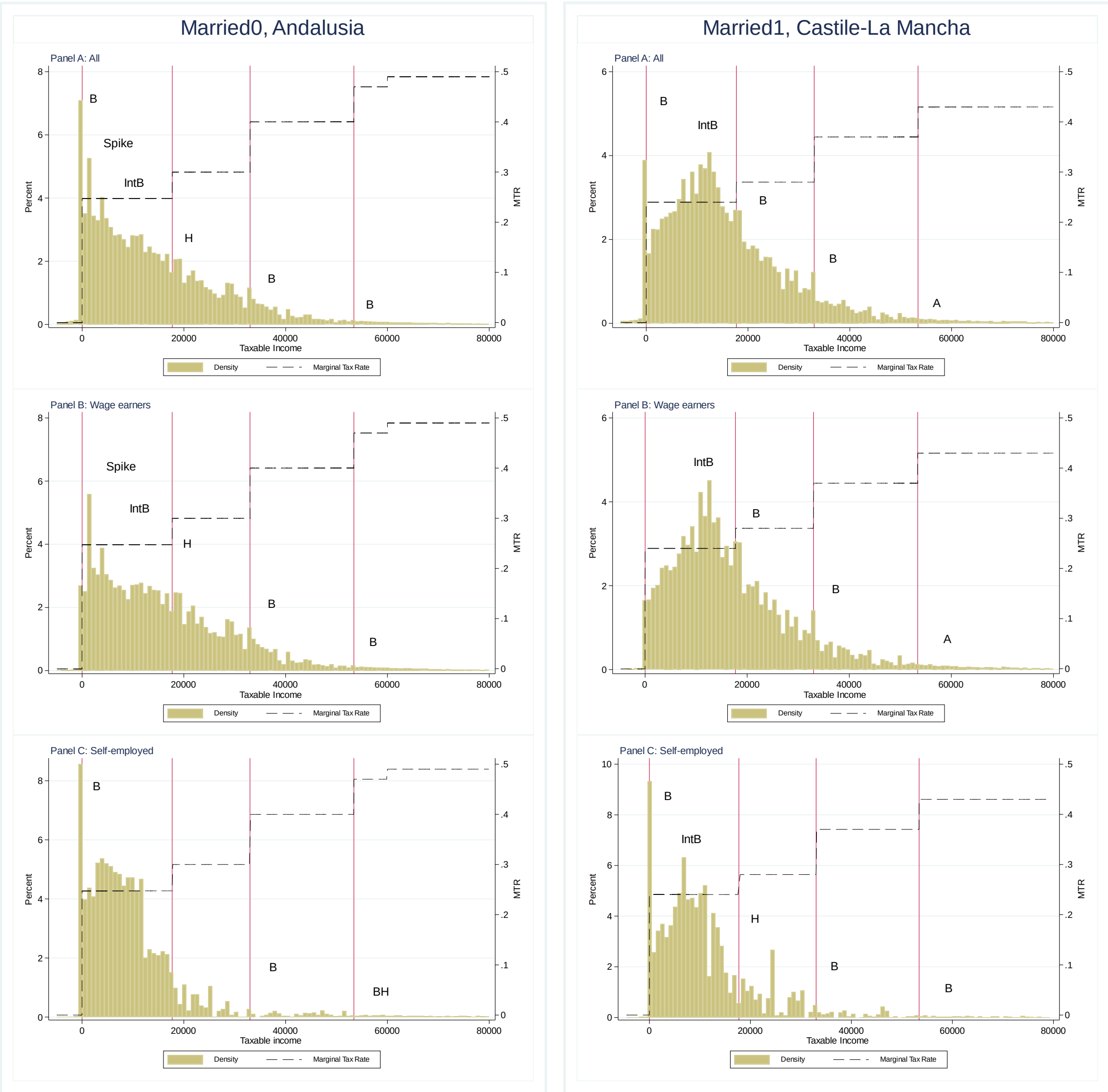
Notes: Panel A displays the histogram of taxable income for Married0, Andalusia (left) and Married1, Castile-La Mancha (right). Panels B and C break all the sample by women and by men, respectively. Taxable income is defined as base income minus itemized deductions. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year over 2010-2014. The MTR schedule is displayed by the dashed line and corresponds to the specific AC. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching: Married0 (4 000€) and Married1 (12 500€).

Figure 2.4: Bunchers, by type of tax return



Notes: Panel A displays the histogram of taxable income for Married0, Andalusia (left) and Married1, Castile-La Mancha (right). Panels B and C break all the sample for taxpayers reporting individually and for taxpayers reporting jointly, respectively. Taxable income is defined as base income minus itemized deductions. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year over 2010-2014. The MTR schedule is displayed by the dashed line and corresponds to the specific AC. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching: Married0 (4 000€) and Married1 (12 500€).

Figure 2.5: Bunchers, by main income source



Notes: Panel A displays the histogram of taxable income for Married0, Andalusia (left) and Married1, Castile-La Mancha (right). Panels B and C break all the sample for wage earners and for self-employed individuals, respectively. Taxable income is defined as base income minus itemized deductions. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year over 2010-2014. The MTR schedule is displayed by the dashed line and corresponds to the specific AC. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching: Married0 (4 000€) and Married1 (12 500€).

Table 2.6: Elasticity of taxable income, bunchers

Kink	Bandwidth	All (1)	Women (2)	Men (3)	Individual (4)	Joint (5)	Wage earners (6)	Self-employed (7)
Panel A: Married0, Andalusia								
1st	1 000 €	12.71***	15.48***	10.04***	1.53***	11.15***	-0.52***	13.85***
		(0.24)	(0.40)	(0.30)	(0.28)	(0.26)	(0.05)	(1.96)
2nd	1 500 €	-0.06	-0.22	0.03	-0.22	0.20	-0.03	0.15
		(0.15)	(0.26)	(0.19)	(0.20)	(0.24)	(0.17)	(0.51)
3rd	1 000 €	0.16**	0.39**	0.07	0.15*	0.19*	0.15**	6.84
		(0.06)	(0.17)	(0.06)	(0.08)	(0.11)	(0.07)	(5.74)
4th	1 000 €	0.05***	0.24***	0.00	0.08***	-0.01	0.06***	-0.10
		(0.02)	(0.06)	(0.02)	(0.02)	(0.02)	(0.02)	(0.05)
IntB	1 000 €	0.41***	1.59***	-	0.83***	-	1.27***	-
		(0.07)	(0.22)	-	(0.17)	-	(0.18)	-
Panel B: Married1, Castile-La Mancha								
1st	2 000 €	3.51***	7.80***	7.23***	0.71**	7.41***	-0.08	5.11***
		(0.41)	(0.98)	(0.87)	(0.33)	(0.53)	(0.14)	(1.40)
2nd	1 500 €	0.63*	0.69	0.59	1.02**	-0.05	0.68**	0.38
		(0.32)	(0.60)	(0.38)	(0.48)	(0.39)	(0.34)	(1.09)
3rd	1 500 €	0.24*	0.36	0.17	0.31[a]	0.04	0.21[b]	0.34
		(0.13)	(0.30)	(0.15)	(0.20)	(0.16)	(0.14)	(0.60)
4th	1 500 €	0.09*	0.02	0.11*	0.08	0.10	0.07	0.38
		(0.05)	(0.10)	(0.05)	(0.06)	(0.08)	(0.05)	(0.28)
IntB	1 500 €	1.13***	-	0.84**	1.25***	0.09	1.10***	-0.76
		(0.42)	-	(0.38)	(0.42)	(0.44)	(0.35)	(0.64)

Notes: Table 2.6 shows the elasticity estimates for the B, BH, A, H, AB and IntB detected in in Fig. 2.3-2.5. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] This is an exceptional case with sharp B at the kink, but p-value of 0.12.
[b] This is an exceptional case with sharp B at the kink, but p-value of 0.12.
[c] (-) means no interior bunching is visually detected in the income distribution.

Table 2.7: Probit regression, (buncher 1)[a]

	Married0, Andalusia (1)	Married1, CM (2)
Men	-0.43***	-0.30***
	(0.00)	(0.00)
Constant	-0.58***	-1.05***
	(0.00)	(0.00)
Joint	0.01***	0.32***
	(0.00)	(0.00)
Constant	-0.82***	-1.34***
	(0.00)	(0.00)
Self-employed	0.18***	0.44***
	(0.00)	(0.00)
Constant	-0.91***	-1.32***
	(0.00)	(0.00)
Capital owners	0.92***	1.09***
	(0.00)	(0.00)
Constant	-0.91***	-1.32***
	(0.00)	(0.00)
N	496893	133077

Notes: Standard errors are in parentheses. Significance levels are *** p<0.01, ** p<0.05, * p<0.1. Controls: marital status, number of child, AC of residence and Year. Base categories: women, individual tax filing and wage earners. Bandwidth 1 500€.
[a] This regression is run to verify who bunch at the first tax kink.

2.5 Anatomy of responses

This section casts further light on the mechanisms behind bunching uncovered until now. In order to have some intuition on how taxpayers bunch, essentially identify the potential channels bunchers use to reduce their taxable income and cluster at tax kinks. This type of analysis is what Slemrod (1996) called the “anatomy of the behavioral response” (Saez *et al.* 2012).

2.5.1 Effects of deductions

In the spirit of Saez (2010) and Doerrenberg et al. (2017), I show the importance of deduction possibilities for optimizing taxable income. For that, in Figure 2.6, I compare the density of gross income (Panel A), the density of base income i.e., defined as gross income minus standard deductions (Panel B) and the density of taxable income i.e., defined as base income minus itemized deductions

(Panel C). This comparison reveals the contribution of standard and itemized deductions to bunching. As before, I focus on Married0 (Andalusia) and Married1 (Castile-La Mancha)[46].

The channels through which taxpayers bunch at kinks are manifold; however, an overall look shows that tax deductions (standard and itemized) may play a crucial role to reduce taxable income in the Spanish PIT schedule. Three evidences confirm this result. First, bunching at the 1^{st} tax kink is more pronounced for TIG than for GIG (for BIG is inexistent), see Figure 2.6. Consistent with visual detection, the elasticity of the 1^{st} tax kink for TIG is the highest (see Table 2.8, column (3)). Second, bunching in the taxable income distribution is more centered around the tax kink. In fact, Figure 2.6 displays asymmetric bunching, bunching-holes and holes in the gross income distribution that become a bunching in the taxable income distribution[47]. Consequently, the elasticity is negative and/or non-significant for GIG, and positive and significant for TIG[48]. Third, interior bunching shifts to the left once I move from GIG to BIG and TIG. In the case of Married0 this shift is from 4 800€ to 4 000€ and in Married1, it is from 13 500€ to 12 500€.

How bunchers bunch? To answer this question, in Figures D.1-D.3 I verify these three evidences for men (in Married1), women (in Married0), wage earners and taxpayers reporting individually. Indeed, Figure D.1 shows that bunching at the 1^{st} tax kink for men (in Married1) and for women (in Married0) is more pronounced for TIG than for GIG[49]. Moreover, Fig. D.1-D.3 display bunching-holes, holes and asymmetric bunching in the gross income distribution that become a bunching in the taxable income distribution[50]. Also, interior bunching shifts to the left once I move from GIG to BIG and TIG. On the whole, this first overlook points out that legal tax reduction responses (LTR) through standard and itemized deductions are a potential channel for optimizing taxable income.

[46] As in previous section, findings for Married1 can be generalized for Married2.

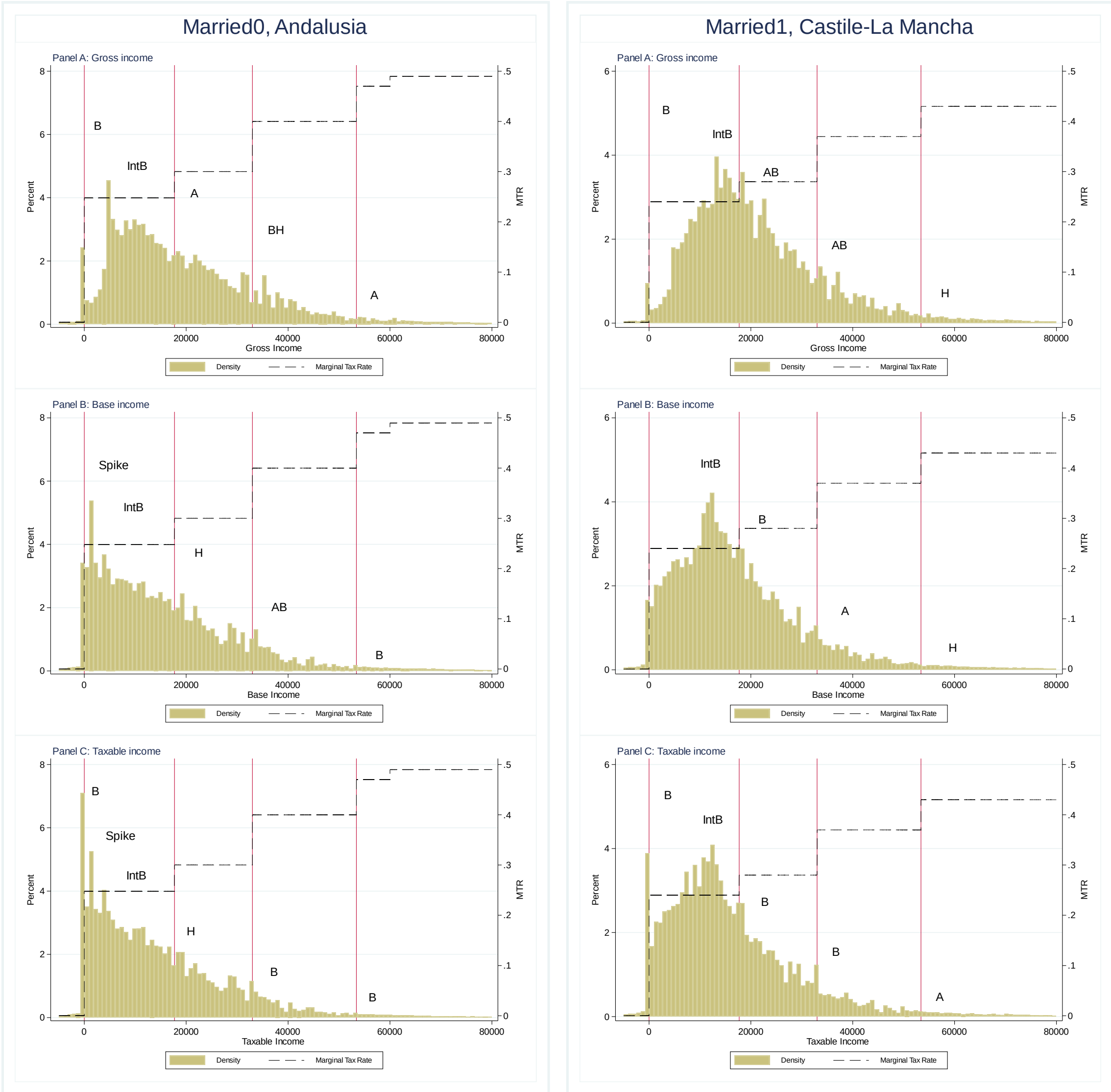
[47] For instance, see Married0, Andalusia, 3^{rd} and 4^{th} kinks, and Married1, CM, 2^{nd}-4^{th} kinks.

[48] For the aforementioned cases, see Table 2.8: Columns (1)-(3), 3^{rd} and 4^{th} kink, Panel A. Columns (1)-(3), 2^{nd}-4^{th} kinks, Panel B.

[49] For empirical confirmation, see Tables D.1 (Panel A) and D.2 (Panel A), 1^{st} kink.

[50] See in Figures D.1-D.3: Married0, Andalusia, 3^{rd} and 4^{th} kinks (women, wage earners and individual) and Married1, CM, 2^{nd}-4^{th} kinks (individual and wage earners). For empirical confirmation see Tables D.1 and D.2.

Figure 2.6: Effects of deductions



Notes: Figure 2.6 displays the histogram of gross income (Panel A), base income (Panel B) and taxable income (Panel C) for married taxpayers with no child in Andalusia (left) and married taxpayers with one child in Castile-La Mancha (right). Graphs in each socio-economic group are for the same AC and the same year in order to be comparable. Gross income is defined as the sum of all sources of income, base income is gross income minus standard deductions and taxable income is base income minus itemized deductions. Histograms are computed using sample weights. The MTR schedule is displayed by the dashed line and corresponds to the AC analyzed. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching, for Married0: GIG (4 800€), BIG (4 000€), TIG (4 000€) and for Married1: GIG (13 500€), BIG (12 500€), TIG (12 500€).

Table 2.8: Income elasticity estimates, effects of deductions

Kink	Bandwidth [a]	Gross income (1)	Base income (2)	Taxable income (3)
Panel A: Married0, Andalusia				
1st	2 000 €	8.27***	2.72***	12.10***
		(0.44)	(0.12)	(0.25)
2nd	1 000 €	0.09	-0.12	-0.02
		(0.11)	(0.11)	(0.13)
3rd	1 000 €	-0.13***	0.13**	0.16**
		(0.03)	(0.06)	(0.06)
4th	1 000 €	0.05	0.04**	0.05***
		(0.03)	(0.09)	(0.02)
IntB	1 000 €	0.33***	0.19***	0.41***
		(0.02)	(0.03)	(0.07)
Panel B: Married1, Castile-La Mancha				
1st	2 000 €	2.05***	0.34***	3.51***
		(0.74)	(0.09)	(0.41)
2nd	1 500 €	0.01	0.33	0.63*
		(0.19)	(0.27)	(0.32)
3rd	1 500 €	0.06	0.33**	0.24*
		(0.09)	(0.15)	(0.13)
4th	1 500 €	-0.09	-0.08*	0.09*
		(0.07)	(0.04)	(0.05)
IntB	1 500 €	0.10**	0.48***	1.13***
		(0.04)	(0.17)	(0.42)

Notes: Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.

2.5.2 Effects of itemizing

In this last subsection I show evidence that part of the response goes through itemized deductions. It is worthwhile to examine these deductions because they can be used more strategically than standard deductions. I analyze the channels that drive bunching for Married0 (Andalusia) and Married1 (Castile-La Mancha). Figure 2.7 displays the density for taxable income of individuals who *only* use the deduction for joint declaration (Itemized_C) and Figure 2.8 displays the density for taxable income of individuals who *only* use deductions to pension contributions (Itemized_PP).

Figures 2.7 and 2.8 capture three clear evidences. First, in Figure 2.7 (Panel A) there is sharp bunching around zero for individuals who only use the deduction for joint filing. This result is consistent with Figure 2.4 where bunchers at the 1st tax kink are taxpayers reporting jointly. The most plausible explanation is that the option of joint tax filing is mostly chosen by households with one breadwinner (usually, men), or by married couples with two or more earners with a significant difference in incomes. Unfortunately, I cannot verify this result using elasticity estimates because of the few observations at this level of disaggregation. Nevertheless, I confirm this result in Table 2.10 (columns (1) and (5)) by running a Probit regression[51]. Second, bunching at the 2nd-4th tax kinks in Figure 2.8 (Panel A) is driven by individuals who only use deductions to pension contributions. The reason why this evidence is more pronounced for married couples than for non-married taxpayers may be due to the fact that they have a higher income and thus, more margin to shift income through pension contributions. In addition, married taxpayers are the only ones who have two additional deductions related to the pension contributions of the spouse (see Table 2.2).

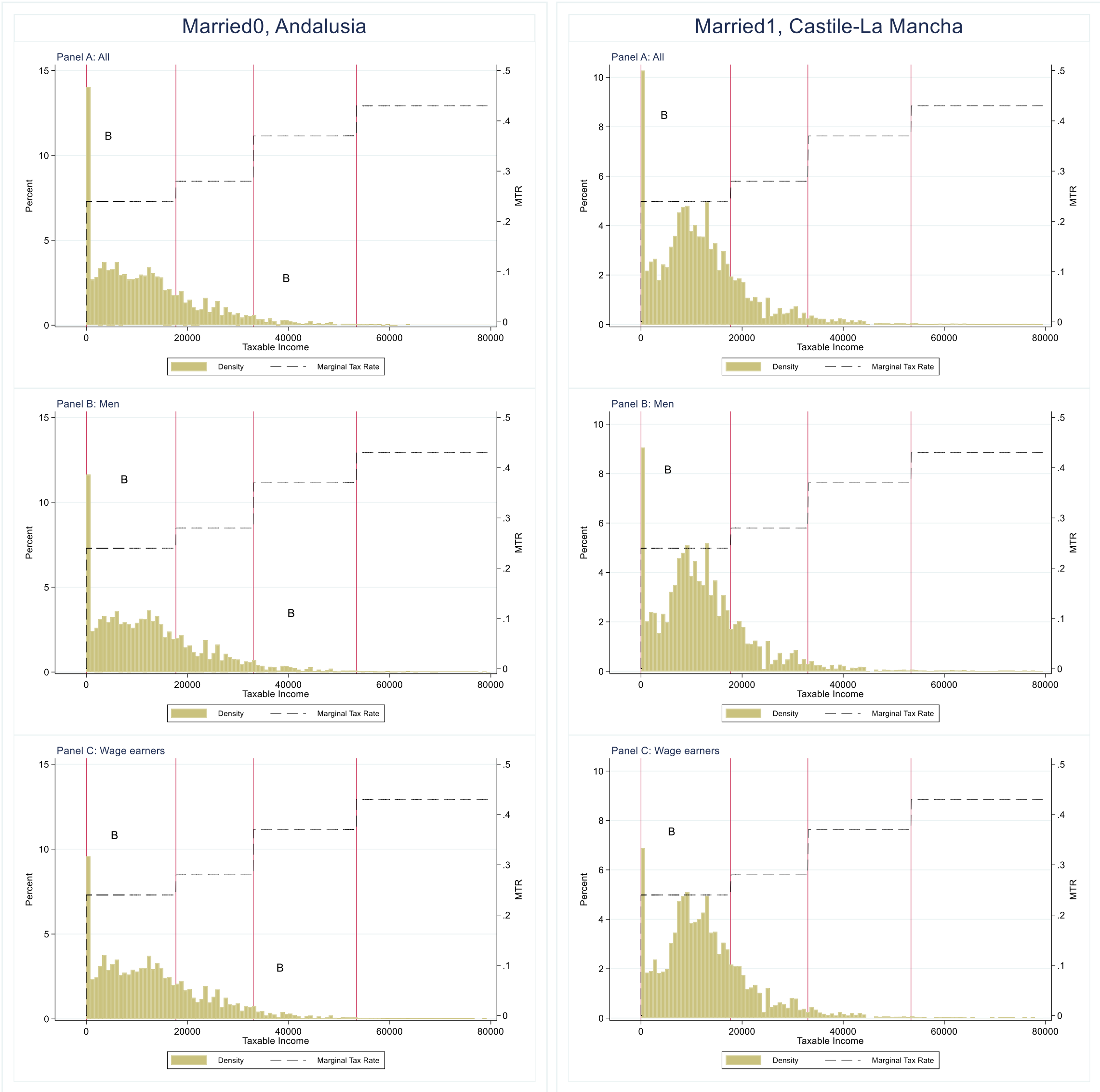
Third, I disaggregate the overall sample by gender and by MIS in Figures 2.7 and 2.8 (Panels B and C). Surprisingly, I find clear bunching at the 2nd-4th tax kinks for men taxpayers who use deductions to pension contributions (see Fig. 2.8, Panel B). This finding indicates that pension contributions are a likely channel for men to bunch at tax kinks, but not for women. This result is consistent with the fact that in Spain around 60% of men on average are title holders of pension plans[52]. As expected, I find clear bunching at the 2nd-4th tax kinks for wage earners who use deductions to pension contributions (see Fig. 2.8, Panel C). These results are confirmed empirically using elasticity estimates in Table 2.9 (columns (2) and (4), Panels B and C) and Table 2.10 (columns (2) - (4), Panels B and C). Ultimately, when I turn to savings tax base I find that bunching at the 2nd and 3rd tax kinks for the self-employed in Married0 and Married1 are driven by those who use deductions to pension contributions (see Fig. E.1, Panel C). Empirically, Table E.1 (column (3)) shows that the elasticity is only significant for Itemized_PP.

All in all, I find that a large share of bunching is driven by tax deductions, essentially by itemized deductions (to both pension contributions and joint taxation). These results confirm that those deductions are an important channel for reducing taxable income to reach tax kinks in the PIT schedule. In addition, these results indicate that itemized deductions among married couples and, more specifically for men and for wage earners, are a key to understanding bunching behavior in Spain.

[51] This regression must be taken with caution as Itemized_C and Itemized_PP are prone to endogeneity, given that there are many pre-existing selection factors (marital status, AC of residence, number of child) associated with the reported income and the use of deductions.

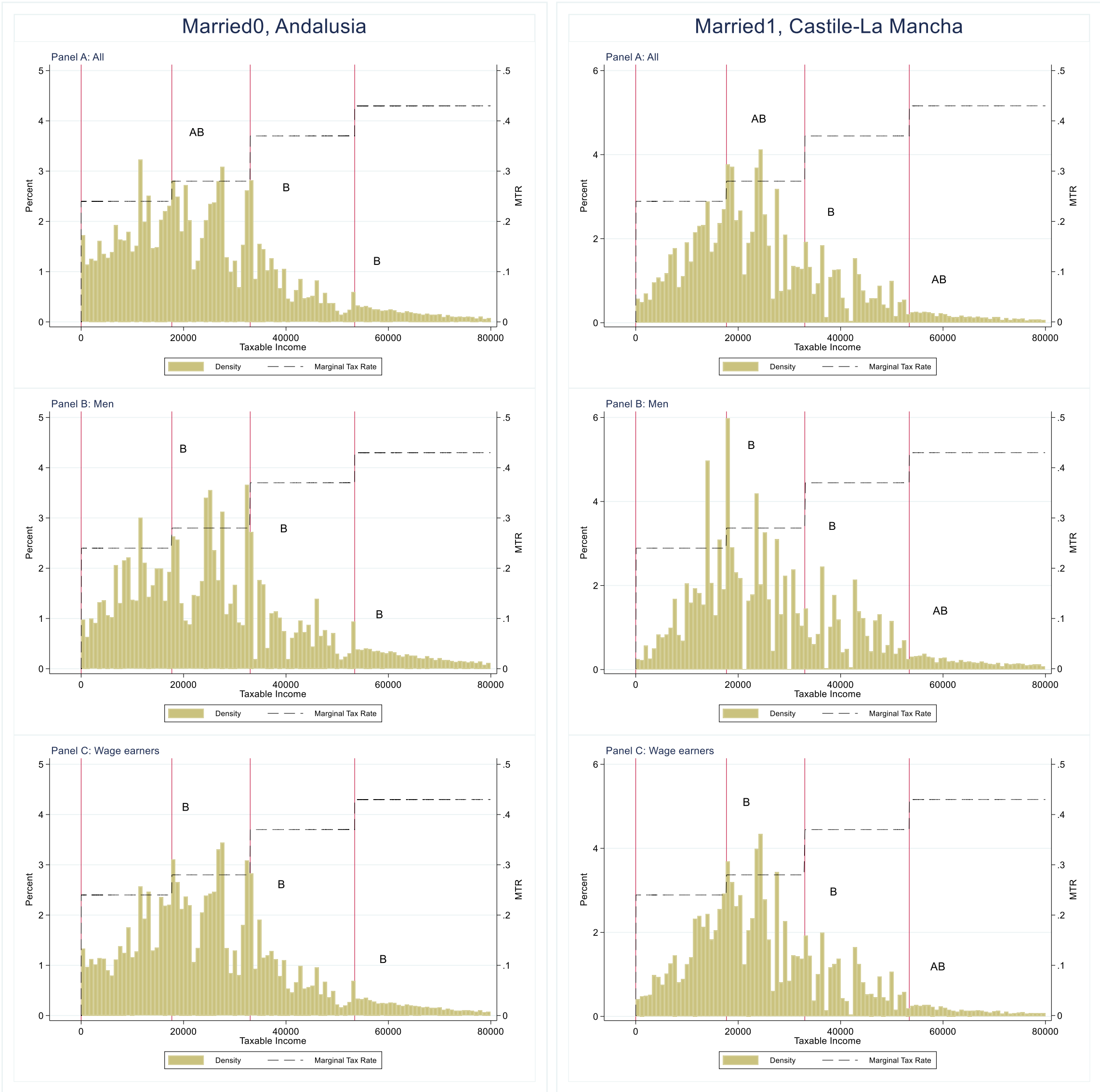
[52] Source: Collective investment and pension funds (in Spanish, Inversión colectiva y fondos de pensiones INVERCO) with dataset from DGSFP, 2010-2014.

Figure 2.7: Effects of itemizing, joint declaration



Notes: Panel A displays the histogram of taxable income for married taxpayers with no child who only use the deduction for joint declaration in Andalusia (left) and married taxpayers with one child who only use the deduction for joint declaration in Castile-La Mancha (right). Panels B and C break the overall sample for men taxpayers and for wage earners, respectively. Taxable income is defined as base income minus itemized deductions. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year over 2010-2014. The MTR is displayed by the dashed line and corresponds to the AC analyzed. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€.

Figure 2.8: Effects of itemizing, pension contributions



Notes: Panel A displays the histogram of taxable income for married taxpayers with no child who use deductions to pension contributions in Andalusia (left) and married taxpayers with one child who use deductions to pension contributions in Castile-La Mancha (right). Panels B and C break the overall sample for men taxpayers and for wage earners, respectively. Taxable income is defined as base income minus itemized deductions. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year over 2010-2014. The MTR is displayed by the dashed line and corresponds to the AC analyzed. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€.

Table 2.9: Elasticity of taxable income, effects of itemizing

Kink	Bandwidth[a]	Itemized_C (1)	Itemized_PP (2)
Panel A: Married0, Andalusia			
2nd	1 500 €	0.09	1.35*
		(0.37)	(0.70)
3rd	1 500 €	0.20	0.42**
		(0.17)	(0.19)
4th	1 500 €	0.08	0.30***
		(0.06)	(0.05)
Panel B: Married0, Andalusia, Men			
2nd	1 500 €	0.26	1.93*
		(0.42)	(1.05)
3rd	1 000 €	0.13	0.66**
		(0.14)	(0.33)
4th	1 500 €	0.06	0.38***
		(0.06)	(0.07)
Panel C: Married0, Andalusia, Wage earners			
2nd	1 500 €	-0.05	1.51*
		(0.38)	(0.79)
3rd	1 500 €	0.24	0.48**
		(0.19)	(0.21)
4th	1 500 €	0.10	0.31***
		(0.06)	(0.06)

Notes: Table 2.9 shows the elasticity estimates for the bunching detected in Fig. 2.7. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.

[a] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.

[b] Itemized_C refers to individuals who *only* use the deduction for joint declaration and Itemized_PP refers to individuals who *only* use deductions to pension contributions.

Table 2.10: Elasticity of taxable income, effects of itemizing

Kink	Bandwidth [a]	Itemized_C (1)	Itemized_PP (2)
Panel A: Married1, Castile-La Mancha			
2nd	2 000 €	0.15	2.16*
		(0.54)	(1.18)
3rd	1 500 €	-0.17	0.45[b]
		(0.16)	(0.33)
4th	1 000 €	0.07	-0.10***
		(0.12)	(0.04)
Panel B: Married1, Castile-La Mancha, Men			
2nd	1 500 €	0.26	3.55*
		(0.52)	(2.11)
3rd	1 500 €	-0.17	0.23
		(0.16)	(0.35)
4th	2 000 €	0.19	-0.14**
		(0.19)	(0.07)
Panel C: Married1, Castile-La Mancha, Wage earners			
2nd	2 000 €	0.20	2.11*
		(0.59)	(1.22)
3rd	1 500 €	-0.20	0.36
		(0.16)	(0.33)
4th	1 000 €	0.03	-0.11***
		(0.11)	(0.04)

Notes: Table 2.10 shows the elasticity estimates for the bunching detected in Fig. 2.8. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.

[a] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.

[b] This is an exceptional case with sharp bunching at the kink, but p-value of 0.18.

[c] Itemized_C refers to individuals who *only* use the deduction for joint declaration and Itemized_PP refers to individuals who *only* use deductions to pension contributions.

Table 2.11: Probit regression, (bunchers 1-4)[a]

	Married0, Andalusia				Married1, Castile-La Mancha			
	1st kink	2nd kink	3rd kink	4th kink	1st kink	2nd kink	3rd kink	4th kink
Panel A: All								
Itemized_C	0.15***	-0.04***	-0.21***	-0.24***	0.36***	-0.02***	-0.42***	-0.34***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-0.93***	-1.44***	-1.88***	-2.58***	-1.32***	-1.33***	-1.83***	-2.58***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Itemized_PP	-0.84***	0.18***	0.61***	0.56***	-0.92***	0.21***	0.42***	0.53***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-0.80***	-1.47***	-2.07***	-2.78***	-1.13***	-1.38***	-2.01***	-2.80***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	50339928	50339928	50339928	50339928	13307718	13307718	13307718	13307718
Panel B: Men								
Itemized_C	0.37***	-0.01***	-0.14***	-0.35***	0.57***	-0.10***	-0.43***	-0.44***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Constant	-1.25***	-1.42***	-1.90***	-2.44***	-1.61***	-1.29***	-1.79***	-2.44***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Itemized_PP	-0.82***	0.05***	0.63***	0.59***	-0.99***	0.23***	0.30***	0.49***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-1.02***	-1.43***	-2.09***	-2.68***	-1.27***	-1.35***	-1.96***	-2.67***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	29695364	29695364	29695364	29695364	8026061	8026061	8026061	8026061
Panel C: Wage earners								
Itemized_C	0.16***	-0.05***	-0.18***	-0.25***	0.36***	-0.03***	-0.44***	-0.32***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.01)
Constant	-1.13***	-1.36***	-1.80***	-2.52***	-1.52***	-1.28***	-1.79***	-2.56***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Itemized_PP	-0.73***	0.11***	0.57***	0.54***	-0.80***	0.13***	0.35***	0.51***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Constant	-1.00***	-1.39***	-1.98***	-2.72***	-1.33***	-1.31***	-1.94***	-2.76***
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
N	39432644	39432644	39432644	39432644	11286429	11286429	11286429	11286429

Notes: Standard errors are in parentheses. Significance levels are *** p<0.01, ** p<0.05, * p<0.1. Controls: (Panel A) Marital status, AC of residence, Number of child, Year; (Panel B) Marital status, AC of residence, Number of child, Year, Men; (Panel C) Marital status, AC of residence, Number of child, Year, Wage earners. Bandwidth 1 500€.
[a] This regression is run to verify who bunch at the first tax kink, second kink, third kink and fourth kink.
[b] Itemized_C refers to individuals who *only* use the deduction for joint declaration and Itemized_PP refers to individuals who *only* use deductions to pension contributions.

2.6 Conclusions

Standard economic theory predicts that individuals bunch at convex kinks of the budget constraint, such as those created by progressive tax systems (Adam *et al.* 2015). In this chapter, I estimate the ETI with respect to the net-of-tax rate in Spain. Using tax return microdata from 2010-

2014 and the bunching approach, I exploit bunching behavior at the first four tax thresholds of the PIT schedule. I show that Spanish taxpayers are sensitive to the tax and to tax modifications. The speed of reaction raises the possibility of compliance responses (LTR and LTA) being more important than real supply responses.

I contribute to the literature by providing empirical evidence on different forms of bunching as bunching-holes, holes, agglomerations, interior bunching and asymmetric bunching. Moreover, the identification of bunchers reveal that married couples, taxpayers filing separately and wage earners have greater sensitivity. Surprisingly, I find that having a child make women less sensitive to taxation. Further exploration of the anatomy of responses reveal that bunching is caused by itemized deductions. In particular, for married couples, for men and for wage earners I identify deductions to pension contributions as the main channel through which taxable income is adjusted. Overall, the empirical results show that the Spanish population responds to taxation and adjusts their taxable income through LTR responses.

The ETI covers labor supply responses and many other aspects on the individual behavior as decisions on savings, fertility, emancipation, marriage. (Arrazola and Hevia, 2017). Therefore, the main contribution of this study is the identification of bunchers and some of their potential channels for tax reduction, crucial for any tax policy design. Nevertheless, I have raised the possibility of income shifting opportunities especially among high-income earners and self-employed individuals. Future work will hopefully extend the static frictionless model I relied on to account for these behavioral responses.

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Supplemental material Chapter 2

2.A Descriptive statistics

Table A.1: Tax schedules pre- and post-reform (Central Government + Regional Government)

Table A.1.1: Andalusia, Catalonia, Castile-Leon

Taxable income (general base)		Marginal tax rates (%)	
Brackets	Nominal thresholds	2011	2012-2014
1	0	0.24	0.2475
2	17 707	0.28	0.3
3	33 007	0.37	0.4
4	53 407	0.43	0.47

Table A.1.2: Valence

Taxable income (general base)		Marginal tax rates (%)		
Brackets	Nominal thresholds	2011	2012-2013	2014
1	0	0.239	0.2475	0.2465
2	17 707	0.2792	0.3	0.2992
3	33 007	0.3695	0.4	0.3995
4	53 407	0.4298	0.47	0.4698

Table A.1.3: Madrid

Taxable income (general base)		Marginal tax rates (%)		
Brackets	Nominal thresholds	2011	2012-2013	2014
1	0	0.236	0.2435	0.2395
2	17 707	0.277	0.297	0.293
3	33 007	0.368	0.398	0.394
4	53 407	0.429	0.469	0.465

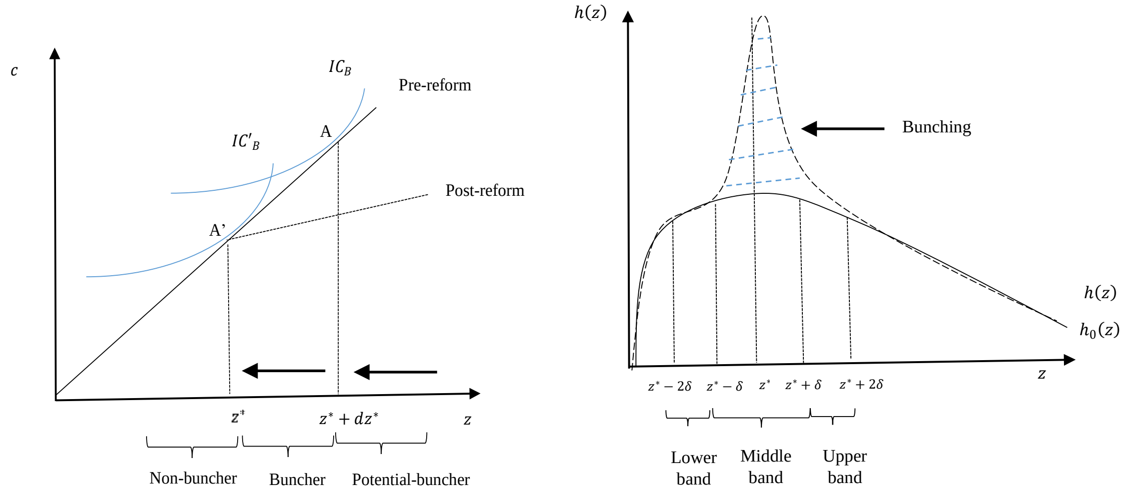
Table A.1.4: Castile-La Mancha

Taxable income (general base)		Marginal tax rates (%)		
Brackets	Nominal thresholds	2011	2012-2013	2014
1	0	0.24	0.2475	0.2375
2	17 707	0.28	0.3	0.3
3	33 007	0.37	0.4	0.4
4	53 407	0.43	0.47	0.47

Table A.2: Summary statistics (non-monetary variables)

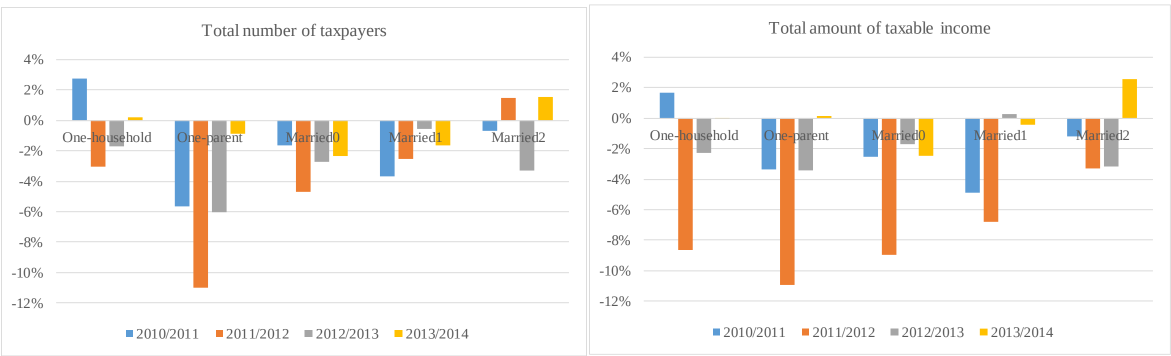
Category	Label	% (One-household)	% (One-parent)	% (Married0)	% (Married1)	% (Married2)
Type of tax return	Joint	0	99.93	29.77	28.06	32.25
	Individual	100	0.07	70.23	71.94	67.75
Marital status	Non-married	100	100	0	0	0
	Married	0	0	100	100	100
Autonomous Community of residence	Andalusia	15.51	16.16	16.06	17.79	20.63
	Castile-Leon	6.51	4.11	6.46	6.06	5.31
	Castile-La Mancha	4.36	3.76	4.51	4.83	5.42
	Catalonia	17.49	20.11	18.22	17.22	17.09
	Valence	10.61	11.11	11.48	11.71	11.26
	Madrid	17.70	17.37	15.34	14.80	15.69
Number of child	0	100	0	100	0	0
	1	0	62.31	0	100	0
	>=2	0	37.70	0	0	100
Gender	Men	56.56	21.97	58.82	59.42	60.78
	Women	43.44	78.03	41.18	40.58	39.22
Main income source	Self-employed	8.33	6.64	10.30	9.18	10.10
	Wage earners	78.95	92.01	80.81	86.38	85.69
	Capital owners	2.73	0.88	6.02	2.36	2.12

Figure A.1: Bunching theory



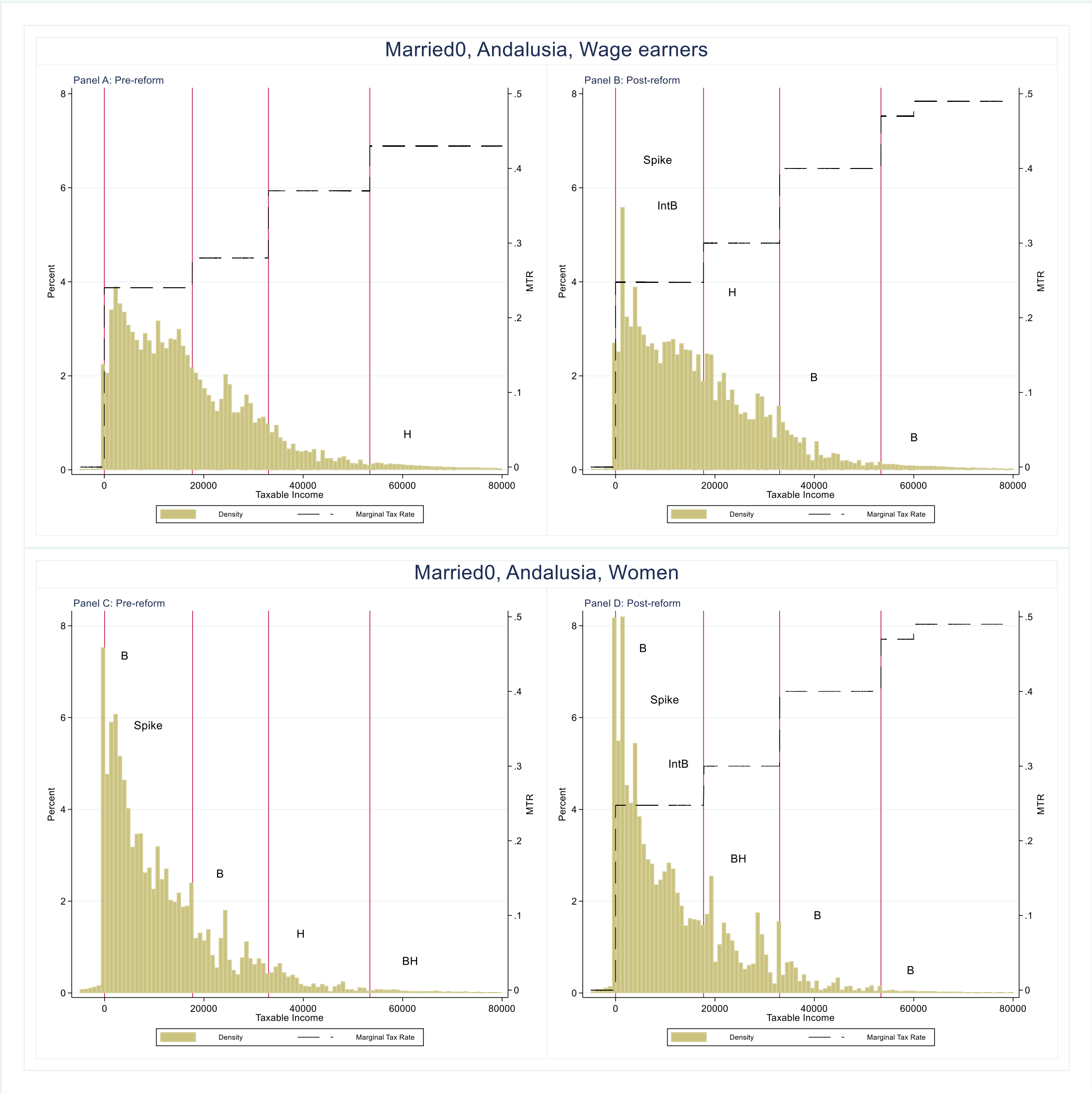
Notes: IC_B is the initial indifference curve of the taxpayer with an income $z^* + dz^*$. The introduction of the kink induces this taxpayer to reduce her income towards z^* and hence, her new indifference curve is IC'_B. IC_N is the indifference curve of the non-buncher (unaffected by the kink). Panel B is the result of Panel A, it illustrates that all taxpayers with an income in $[z^*, z^* + dz^*]$ cluster around the kink point (z^*) creating bunching in the new income distribution ($h(z)$). Source: Saez (2010, p. 184).

Figure A.2: Growth rates



2.B Additional evidence: Dynamics of bunching

Figure B.1: Dynamics of bunching



Notes: Figure B.1 displays the histogram of taxable income for married taxpayers with no child in Andalusia. Panels A and B are for wage earners, and Panels C and D are for women. Taxable income is defined as base income minus itemized deductions and is the same in both years. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year before and after the reform. The MTR schedule is displayed by the dashed line and corresponds to each year (taking into account the tax reform) for the correspondent AC. The first four tax kink points are displayed by the vertical lines on the graph and are the same in both years: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching is at 4 000€ in the post-reform year for both groups.

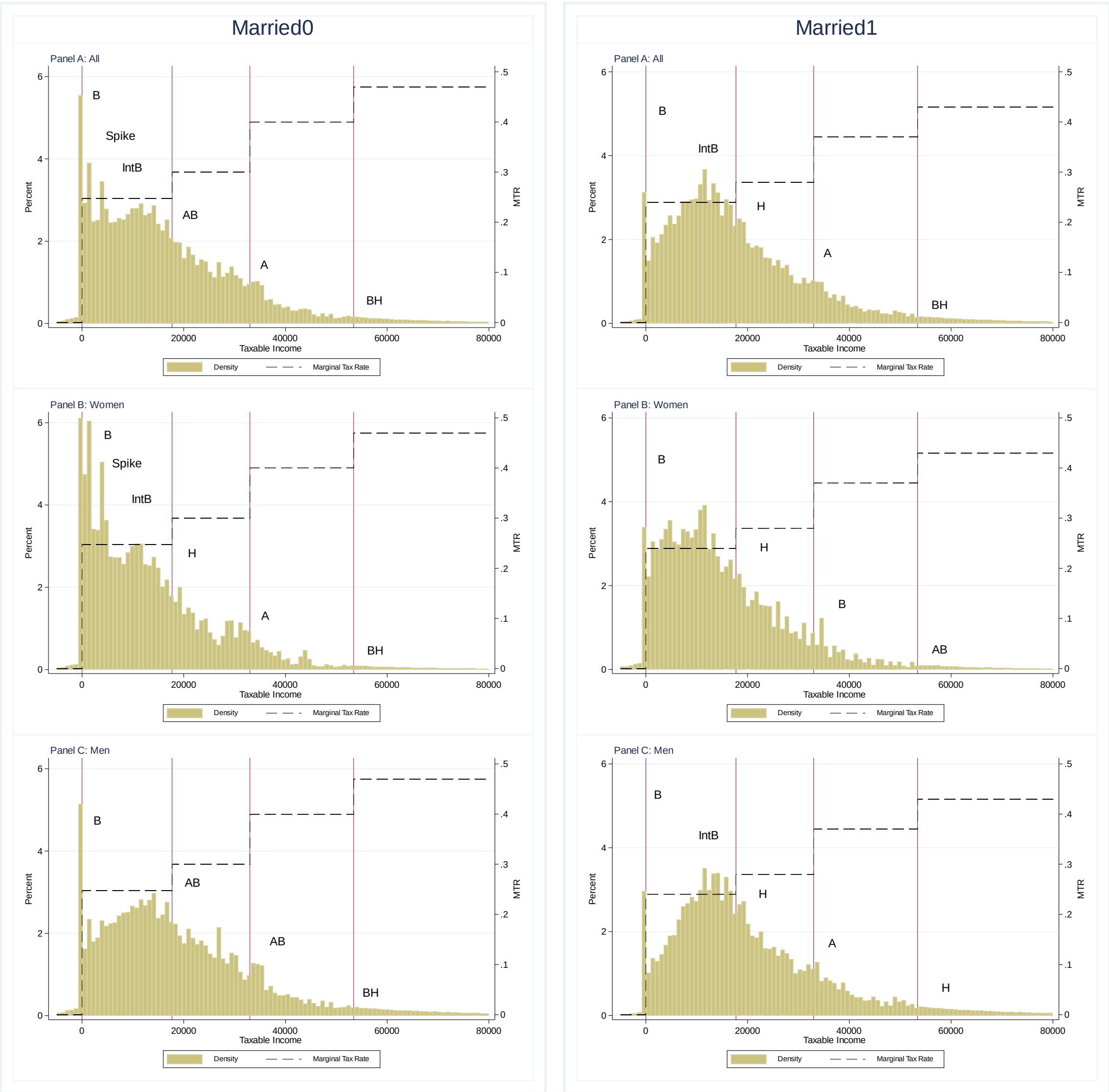
Table B.1: Elasticity of taxable income, dynamics of bunching

Kink	Bandwidth [a]	Pre-reform year (1)	Post-reform year (2)
Panel A: Married0, Andalusia, Wage earners			
1st	1 500 €	0.25***	4.67***
		(0.09)	(0.43)
2nd	1 500 €	-0.03	-0.03
		(0.21)	(0.17)
3rd	1 000 €	-0.07*	0.15**
		(0.04)	(0.07)
4th	1 000 €	-0.10***	0.06***
		(0.01)	(0.09)
IntB	1 000 €	-	1.27***
		-	(0.18)
Panel B: Married0, Andalusia, Women			
1st	1 500 €	10.59***	15.48***
		(0.56)	(0.40)
2nd	1 500 €	0.64	-0.22
		(0.44)	(0.26)
3rd	1 000 €	-0.13**	0.39**
		(0.06)	(0.17)
4th	1 000 €	-0.23***	0.24***
		(0.02)	(0.06)
IntB	1 000 €	-	1.59***
		-	(0.22)

Notes: Table B.1 shows the elasticity estimates for the B, BH, A, H, AB and IntB detected in the pre- and post-reform year in Fig. B.1. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.
[b] (-) means no interior bunching is visually detected in the income distribution.

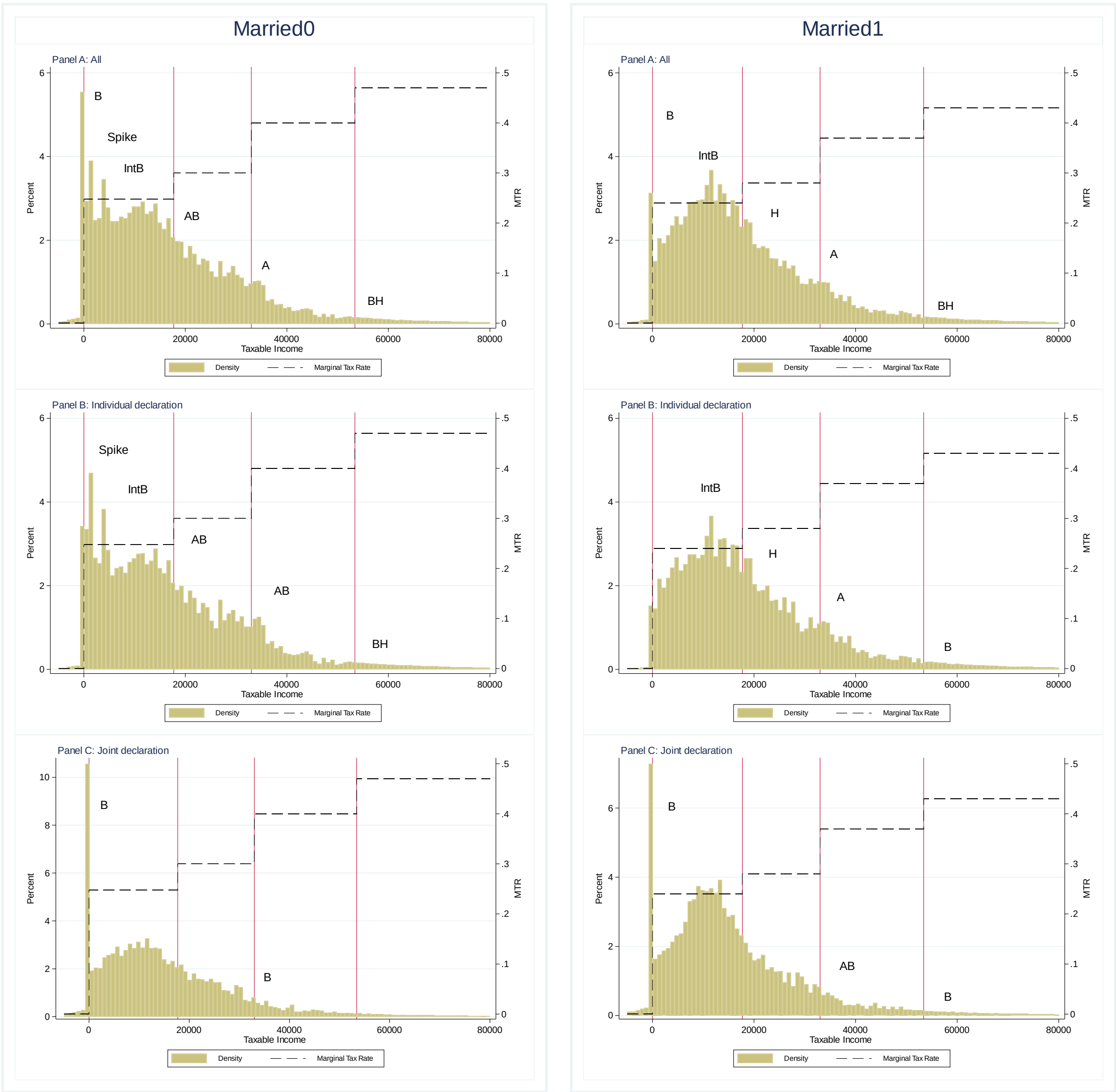
2.C Additional evidence: Bunchers

Figure C.1: Bunchers, by gender



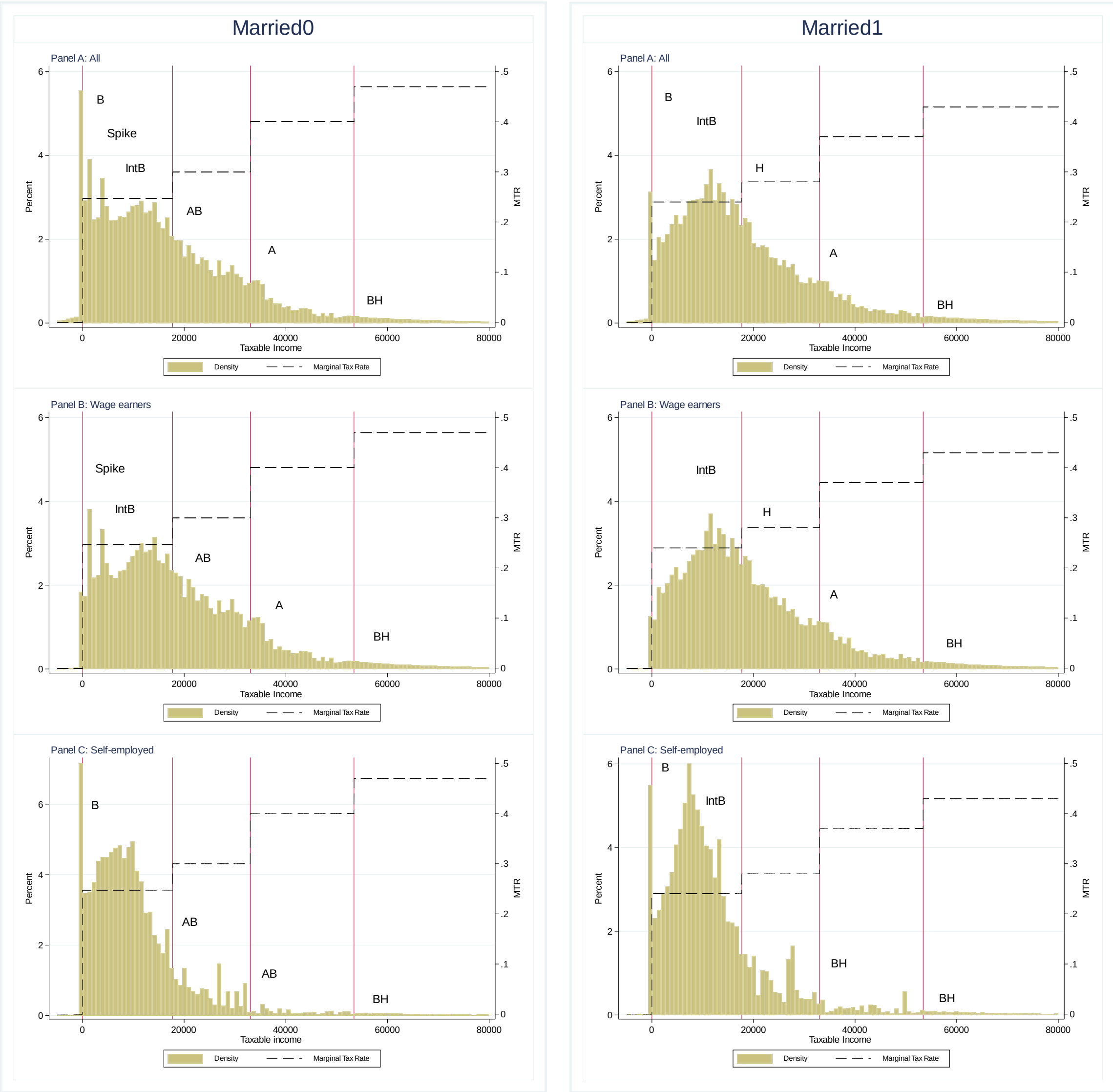
Notes: Panel A displays the histogram of taxable income for Married0 (left) and Married1 (right). Panels B and C break all the sample for women and for men, respectively. Taxable income is defined as base income minus itemized deductions. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year over 2010-2014. In this case I have generalized the MTRs because the figure is not for a specific AC. The first four tax kink points are displayed by the vertical lines on the graph and are the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching: Married0 (4 000€) and Married1 (12 500€).

Figure C.2: Bunchers, by type of tax return



Notes: Panel A displays the histogram of taxable income for Married0 (left) and Married1 (right). Panels B and C break all the sample for taxpayers reporting individually and for taxpayers reporting jointly, respectively. Taxable income is defined as base income minus itemized deductions. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year over 2010-2014. In this case I have generalized the MTRs because the figure is not for a specific AC. The first four tax kink points are displayed by the vertical lines on the graph and are the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching: Married0 (4 000€) and Married1 (12 500€).

Figure C.3: Bunchers, by main income source



Notes: Panel A displays the histogram of taxable income for Married0 (left) and Married1 (right). Panels B and C break all the sample for wage earners and for self-employed individuals, respectively. Taxable income is defined as base income minus itemized deductions. I consider income from all sources, except savings. Histograms are computed using sample weights and for a given year over 2010-2014. In this case I have generalized the MTRs because the figure is not for a specific AC. The first four tax kink points are displayed by the vertical lines on the graph and are the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching: Married0 (4 000€) and Married1 (12 500€).

Table C.1: Elasticity of taxable income, bunchers

Kink	Bandwidth	All (1)	Women (2)	Men (3)	Individual (4)	Joint (5)	Wage earners (6)	Self-employed (7)
Panel A: Married0								
1st	1 000 €	9.29***	9.59***	9.03***	5.50***	10.57***	-0.43***	11.36***
		(0.13)	(0.29)	(0.12)	(0.35)	(0.10)	(0.03)	(0.74)
2nd	1 500 €	0.12*	-0.18*	0.32***	0.12	0.11	0.18**	-0.10
		(0.06)	(0.10)	(0.08)	(0.09)	(0.10)	(0.07)	(0.19)
3rd	1 000 €	0.00	0.02	-0.01	-0.01	0.03	0.02	-0.28***
		(0.02)	(0.03)	(0.02)	(0.02)	(0.03)	(0.01)	(0.02)
4th	1 500 €	0.04***	0.00	0.05***	0.05***	0.00	0.04***	-0.04*
		(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.01)	(0.03)
IntB	1 000 €	1.49***	2.44***	-	2.07***	-	1.94***	-
		(0.08)	(0.11)	-	(0.09)	-	(0.09)	-
Panel B: Married1								
1st	1 500 €	7.12***	11.26***	10.73***	3.82***	8.66***	0.94***	5.45***
		(0.17)	(0.22)	(0.20)	(0.30)	(0.12)	(0.07)	(0.48)
2nd	1 500 €	0.14	0.30*	0.06	0.21*	-0.03	0.16*	-0.16
		(0.09)	(0.17)	(0.10)	(0.12)	(0.13)	(0.09)	(0.27)
3rd	2 000 €	0.14***	0.19***	0.11***	0.17***	0.03	0.14***	0.10
		(0.04)	(0.07)	(0.04)	(0.05)	(0.05)	(0.04)	(0.12)
4th	1 500 €	-0.02***	0.24***	-0.08***	-0.03***	0.01	-0.03***	0.11**
		(0.01)	(0.03)	(0.01)	(0.01)	(0.01)	(0.01)	(0.04)
IntB	1 500 €	0.44***	-	0.58***	0.42***	-	0.45***	0.11
		(0.09)	-	(0.12)	(0.12)	-	(0.10)	(0.24)

Notes: Table C.1 shows the elasticity estimates for the B, BH, A, H, AB and IntB detected in Fig. C.1-C3. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.

Table C.2: Probit regression, (buncher 1)[a]

	Married0 (1)	Married1 (2)
Men	-0.41***	-0.33***
	(0.00)	(0.00)
Constant	-0.78***	-1.13***
	(0.00)	(0.00)
Joint	0.11***	0.31***
	(0.00)	(0.00)
Constant	-1.03***	-1.41***
	(0.00)	(0.00)
Self-employed	0.27***	0.31***
	(0.00)	(0.00)
Constant	-1.13***	-1.38***
	(0.00)	(0.00)
Capital owners	1.23***	1.10***
	(0.00)	(0.00)
Constant	-1.13***	-1.38***
	(0.00)	(0.00)
N	3057464	2689616

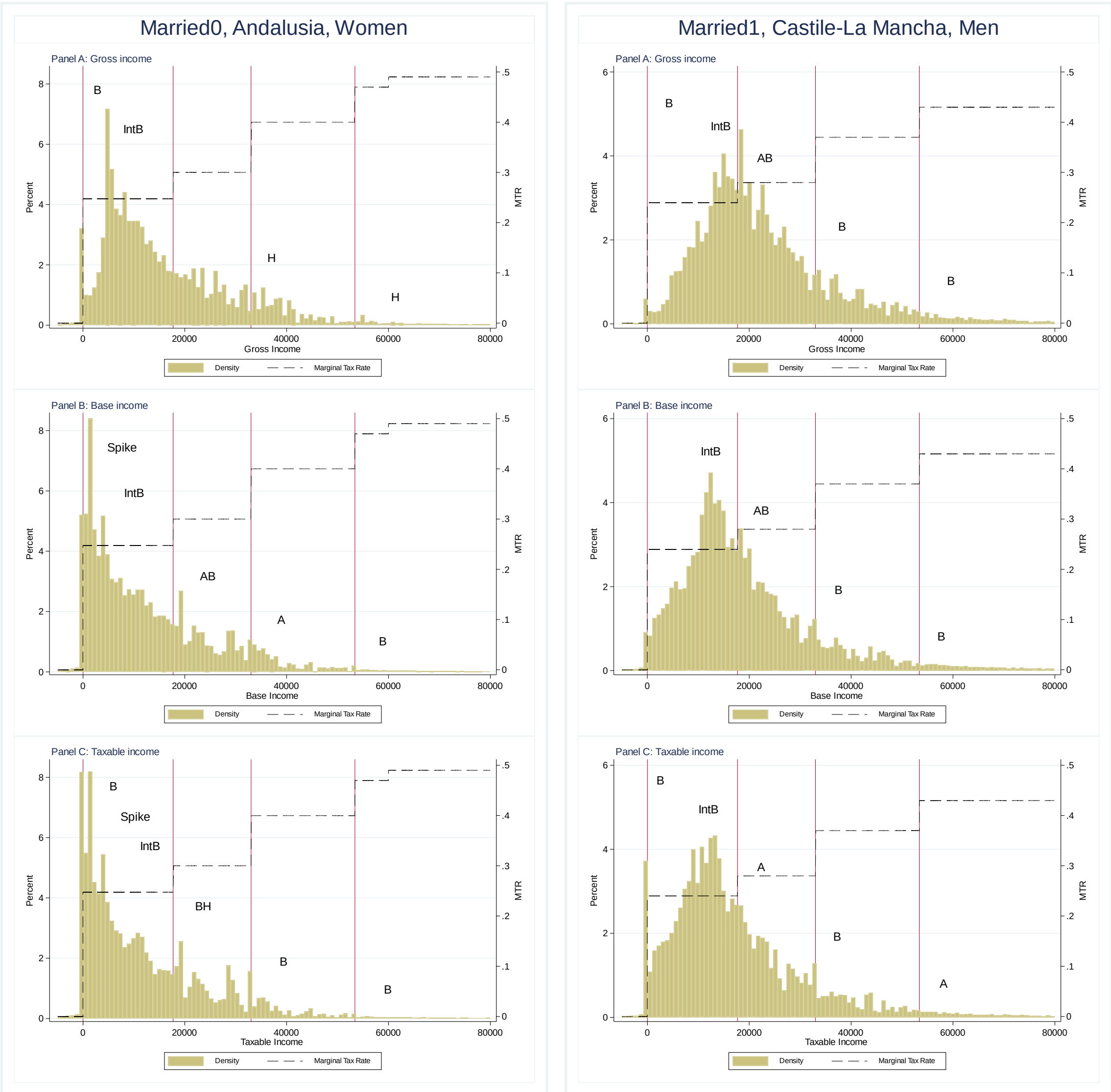
Notes: Standard errors are in parentheses. Significance levels are *** p<0.01, ** p<0.05, * p<0.1. Controls: marital status, number of child and Year. Base categories: women, individual tax filing and wage earners. Bandwidth 1 500€.

[a] This regression is run to verify who bunch at the first tax kink.

[b] (-) means no interior bunching is visually detected in the income distribution.

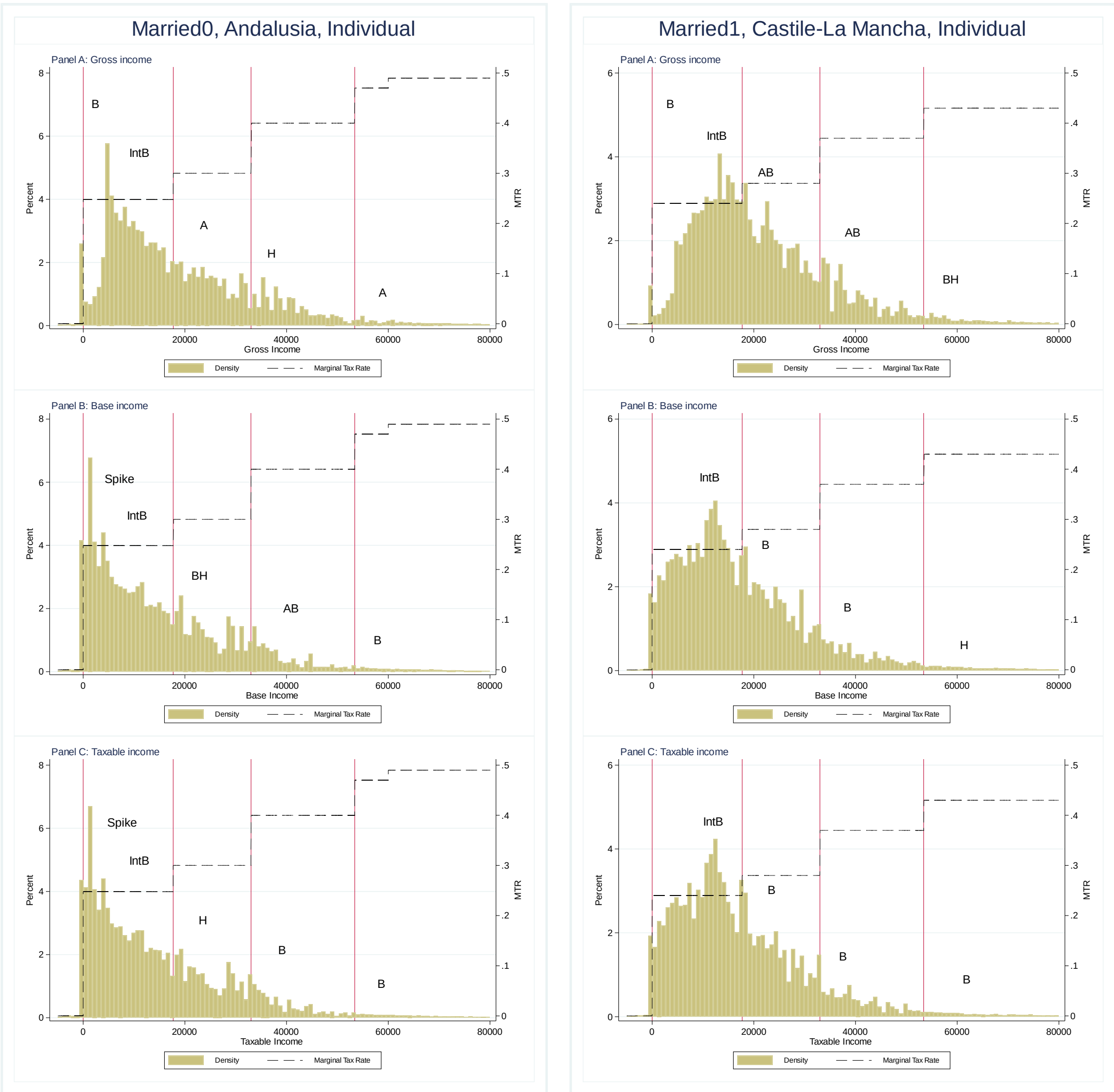
2.D Additional evidence: Effects of deductions

Figure D.1: Effects of deductions, by gender



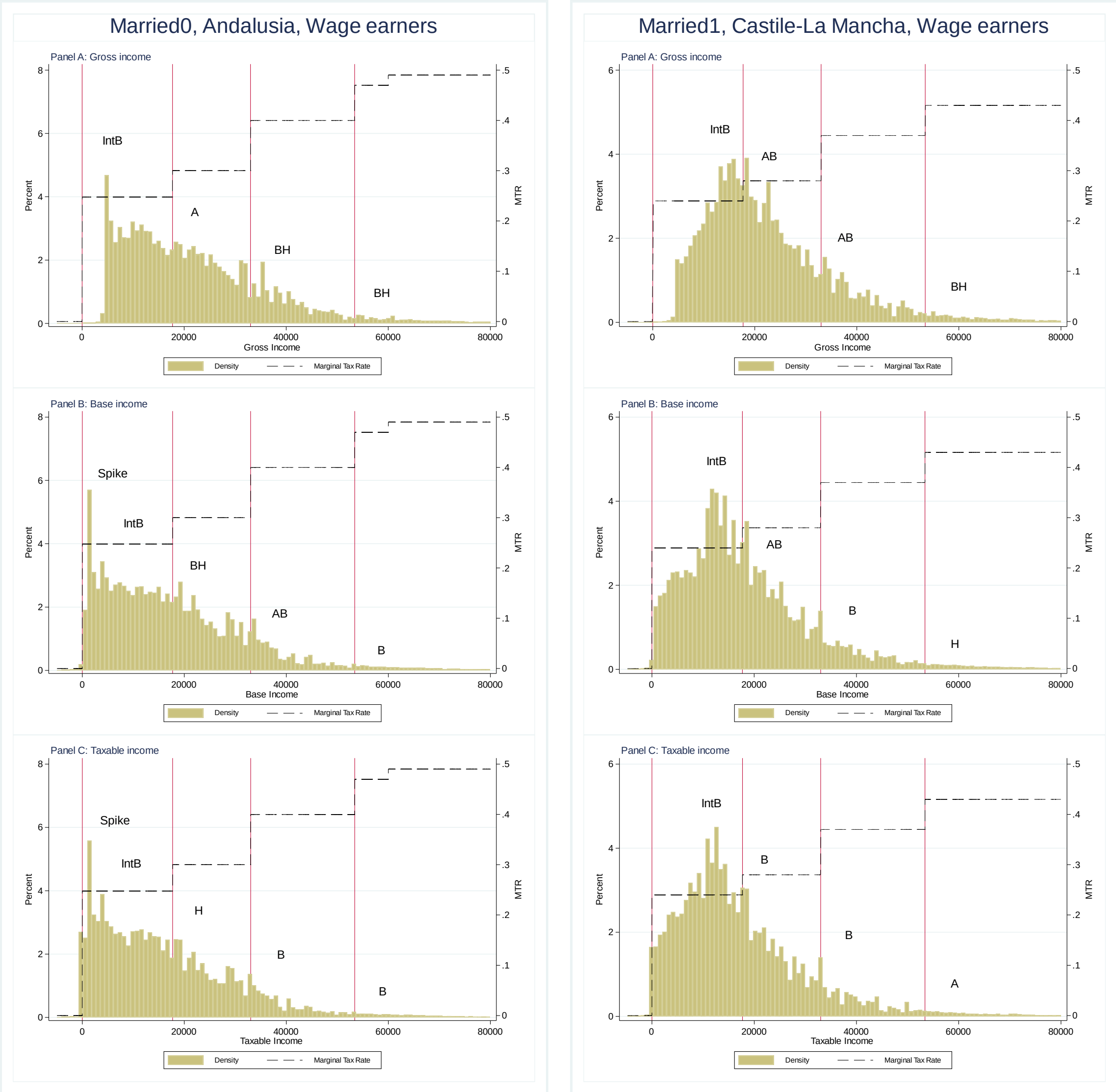
Notes: Figure D.1 displays the histogram of gross income (Panel A), base income (Panel B) and taxable income (Panel C) for married women taxpayers with no child in Andalusia (left) and married men taxpayers with one child in Castile-La Mancha (right). Graphs in each socio-economic group are for the same AC and the same year in order to be comparable. Gross income is defined as the sum of all sources of income, base income is gross income minus standard deductions and taxable income is base income minus itemized deductions. Histograms are computed using sample weights. The MTR schedule is displayed by the dashed line and corresponds to the AC analyzed. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching, for Married0: GIG (4 800€), BIG (4 000€), TIG (4 000€) and for Married1: GIG (13 500€), BIG (12 500€), TIG (12 500€).

Figure D.2: Effects of deductions, by type of tax return



Notes: Figure D.2 displays the histogram of gross income (Panel A), base income (Panel B) and taxable income (Panel C) for married taxpayers with no child who report individually in Andalusia (left) and married taxpayers with one child who report individually in Castile-La Mancha (right). Graphs in each socio-economic group are for the same AC and the same year in order to be comparable. Gross income is defined as the sum of all sources of income, base income is gross income minus standard deductions and taxable income is base income minus itemized deductions. Histograms are computed using sample weights. The MTR schedule is displayed by the dashed line and corresponds to the AC analyzed. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching, for Married0: GIG (4 800€), BIG (4 000€), TIG (4 000€) and for Married1: GIG (13 500€), BIG (12 500€), TIG (12 500€).

Figure D.3: Effects of deductions, by main income source



Notes: Figure D.3 displays the histogram of gross income (Panel A), base income (Panel B) and taxable income (Panel C) for married wage earners with no child in Andalusia (left) and married wage earners with one child in Castile-La Mancha (right). Graphs in each socio-economic group are for the same AC and the same year in order to be comparable. Gross income is defined as the sum of all sources of income, base income is gross income minus standard deductions and taxable income is base income minus itemized deductions. Histograms are computed using sample weights. The MTR schedule is displayed by the dashed line and corresponds to the AC analyzed. The first four tax kink points are displayed by the vertical lines on the graph and are exactly the same in both AC: 0€, 17 707€, 33 007€, 53 407€. Bins 100€. Interior bunching, for Married0: GIG (4 800€), BIG (4 000€), TIG (4 000€) and for Married1: GIG (13 500€), BIG (12 500€), TIG (12 500€).

Table D.1: Income elasticity estimates, effects of deductions

Kink	Bandwidth [a]	Gross income (1)	Base income (2)	Taxable income (3)
Panel A: Married0, Andalusia, Women				
1st[b]	1 000 €	-	-	5.54***
		-	-	(0.59)
2nd	1 000 €	0.00	-0.46***	-0.36**
		(0.18)	(0.15)	(0.17)
3rd	1 000 €	-0.13***	0.19	0.39**
		(0.05)	(0.12)	(0.17)
4th	1 000 €	-0.08*	0.37***	0.24***
		(0.04)	(0.08)	(0.06)
IntB	1 000 €	1.71***	0.29***	1.59***
		(0.09)	(0.05)	(0.22)
Panel B: Married0, Andalusia, Individual				
1st[b]	1 000 €	-	-	1.53***
		-	-	(0.28)
2nd	1 000 €	-0.01	-0.26*	-0.13
		(0.15)	(0.15)	(0.16)
3rd	1 000 €	-0.19***	0.12	0.15*
		(0.03)	(0.08)	(0.08)
4th	1 000 €	-0.02	0.08***	0.08***
		(0.04)	(0.03)	(0.02)
IntB	1 000 €	0.89***	0.24***	0.83***
		(0.05)	(0.04)	(0.17)
Panel C: Married0, Andalusia, Wage earners				
1st[b]	1 000 €	-	-	-0.52***
		-	-	(0.05)
2nd	1 000 €	0.11	-0.04	0.03
		(0.12)	(0.13)	(0.14)
3rd	1 000 €	-0.14***	0.13**	0.15**
		(0.03)	(0.06)	(0.07)
4th	1 000 €	0.03	0.06***	0.06***
		(0.04)	(0.02)	(0.02)
IntB	1 000 €	2.05***	0.22***	1.27***
		(0.12)	(0.04)	(0.18)

Notes: Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.
[b] (-) means no interior bunching is visually detected in the income distribution.
[c] Note that Married0 has a spike at 1 500€ with TIG. This spike is not taken as an interior bunching because it is captured in the bunching window of the 1st kink. It must be taken with caution because it can over-estimate the ETI.

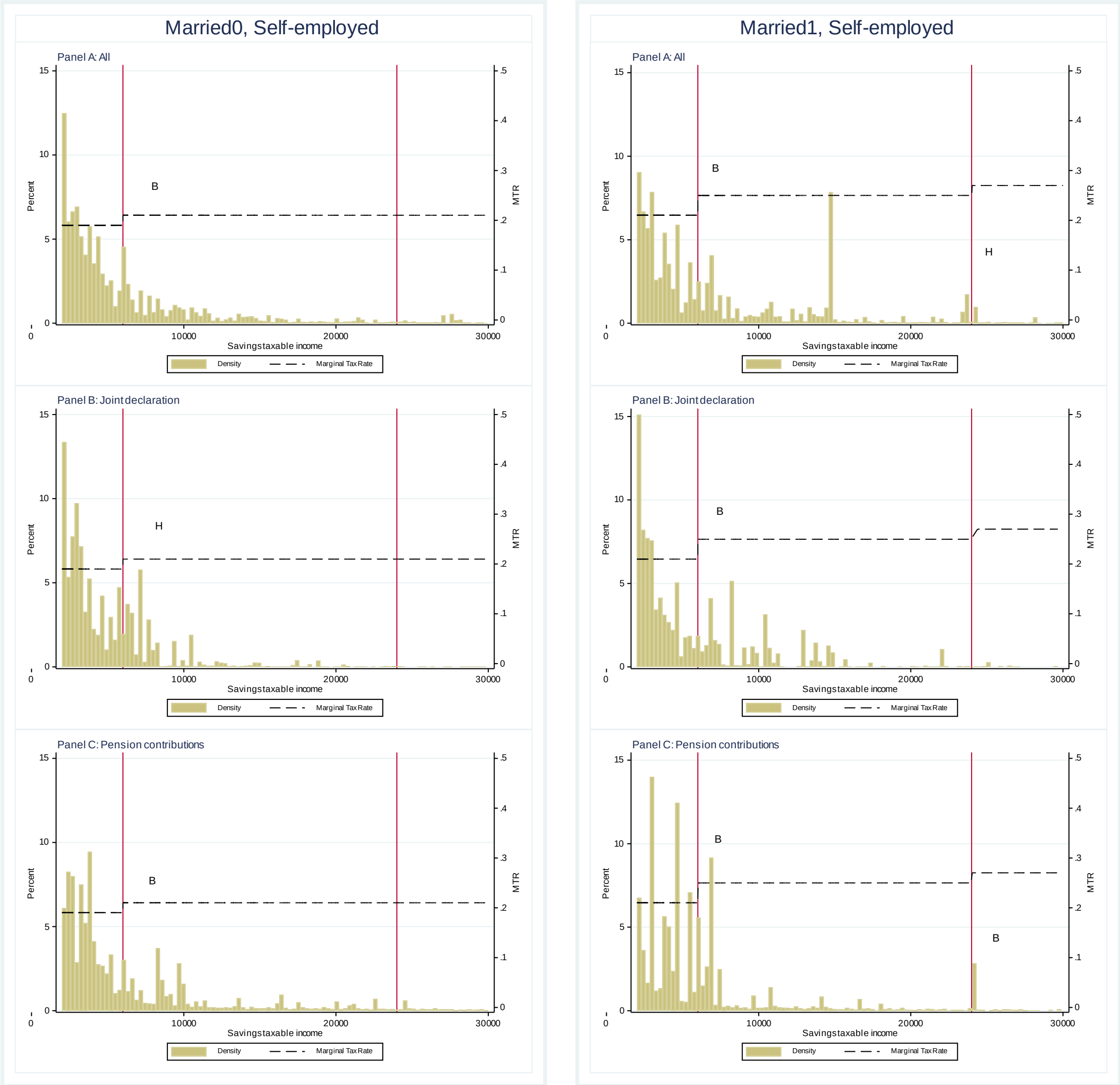
Table D.2: Income elasticity estimates, effects of deductions

Kink	Bandwidth [a]	Gross income (1)	Base income (2)	Taxable income (3)
Panel A: Married1, CM, Men				
1st	2 000 €	-	-	4.17***
		-	-	(0.60)
2nd	1 500 €	0.19	0.46	0.59
		(0.24)	(0.32)	(0.38)
3rd	1 500 €	0.02	0.38*	0.17
		(0.12)	(0.20)	(0.15)
4th	1 500 €	0.02	-0.15***	0.11*
		(0.10)	(0.04)	(0.05)
IntB	1 500 €	0.18***	0.17***	0.84**
		(0.06)	(0.07)	(0.382)
Panel B: Married1, CM, Individual				
1st	2 000 €	-	-	0.71**
		-	-	(0.33)
2nd	1 500 €	0.20	0.54	1.02**
		(0.29)	(0.43)	(0.48)
3rd	1 500 €	0.18	0.39*	0.31
		(0.15)	(0.23)	(0.20)
4th	1 500 €	-0.06	-0.10**	0.08
		(0.10)	(0.05)	(0.06)
IntB	1 500 €	0.09*	0.17***	1.25***
		(0.05)	(0.07)	(0.42)
Panel C: Married1, CM, Wage earners				
1st	2 000 €	-	-	-0.08
		-	-	(0.14)
2nd	1 500 €	0.01	0.45	0.68**
		(0.20)	(0.29)	(0.34)
3rd	1 500 €	0.05	0.34**	0.21
		(0.10)	(0.17)	(0.14)
4th	1 500 €	-0.07	-0.11***	0.07
		(0.08)	(0.04)	(0.05)
IntB	1 500 €	0.07	0.23***	1.10***
		(0.04)	(0.07)	(0.35)

Notes: Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.
[b] (-) means no interior bunching is visually detected in the income distribution.

2.E Additional evidence: Effects of itemizing

Figure E.1: Effects of itemizing, savings taxable income



Notes: Panel A displays the histogram of savings taxable income for Married0 (left) and Married1 (right). Panels B and C break the overall sample for taxpayers who only use the deduction for joint declaration and for those who use deductions to pension contributions, respectively. Savings taxable income contains shareholder funds, equity capital, insurances (life, disability), capitalization operations and life annuities. I have restricted the range to observations above 2 000€ to avoid the spike at zero. Histograms are computed using sample weights and for a given year over 2010-2014. In this case, I have generalized the MTRs from savings taxable income because the figure is not for a specific AC. Two tax kink points are displayed by the vertical lines on the graph: 6 000€ and 24 000€. Bins 100€.

Table E.1: Elasticity of taxable income, effects of itemizing

Kink[d]	Bandwidth	All (1)	Itemized_C (2)	Itemized_PP (3)
Panel A: Married0, Self-employed				
2nd	200	3.26***	-0.10	1.51**
		(0.76)	(0.89)	(0.74)
3rd	200	-	-	-
		-	-	-
Panel B: Married1, Self-employed				
2nd	150	0.90**	0.16	5.64**
		(0.37)	(0.53)	(2.38)
3rd	150	-0.45***	-	-0.44***
		(0.02)	-	(0.03)

Notes: Table E.1 shows the elasticity estimates for the bunching detected in Fig. E.1. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.
[b] Itemized_C refers to individuals who *only* use the deduction for joint declaration and Itemized_PP refers to individuals who *only* use deductions to pension contributions.
[c] (-) means no interior bunching is visually detected in the income distribution.
[d] . I have restricted the range to observations above 2 000€ to avoid the spike at zero. Therefore, the 2nd and the 3rd tax kinks are displayed in Fig. E.1.

Chapter 3

How much does it cost to Spanish taxpayers to raise an additional euro of tax revenue?

3.1 Introduction

"There are many fascinating theoretical and empirical issues to be addressed in public finance. But none is more important than measuring the effects of tax rate changes and the costs of incremental tax revenue" (Feldstein 1996, p. 27). Chapter 3 addresses both captivating issues through the estimation of the marginal costs of public funds (MCF). The MCF is one of the most important concepts in the field of public economics as it captures the costs of an increment on public spending. These costs – known as the costs of taxation – depend both on the "magnitude of the tax rate change that is required to raise the needed revenue and the deadweight loss associated with such change" (Feldstein 1996, p. 21)[1]. Both, in turn, depend on a full range of behavioral responses of taxpayers to the modification of marginal tax rates (MTRs). These behavioral responses arise because taxpayers alter their economic decisions and engage in certain activities to minimize the effect of tax changes[2]. In this way, taxes distort the allocation of resources in an economy producing inefficiencies and reducing tax revenue by a substantial amount. For this reason, in the last decades, a wide range of empirical studies have used the elasticity of taxable income (ETI) to calculate the marginal distortionary costs of taxation. This parameter – introduced by Feldstein (1995, 1999) – has the advantage to capture all behavioral responses to taxation in a single elasticity measure and be used, under some assumptions, to study the efficiency costs and the welfare implications associated to tax reforms (Saez *et al.* 2012).

[1] Slemrod and Yitzhaki (1996) encountered four additional costs apart from the deadweight loss: the administrative costs, the compliance costs, the excess burden of tax evasion and the avoidance costs. This work only considers the deadweight loss.

[2] There are three types of behavioral responses: tax evasion, tax avoidance and real responses (changes in hours of work, effort, productivity, etc.). Income shifting is classified as a tax avoidance response and takes two forms: (i) inter-income shifting, that is when taxpayers alter the timing of their reported income, and (ii) intra-income shifting, that is when income is shifted between individuals or tax bases. This work focus on intra-income shifting responses between tax bases, so I will use the term income shifting and intra-income shifting interchangeably throughout the chapter.

The aim of this chapter is twofold. First, calculate the costs of financing incremental government spending associated with the implementation of the Royal-Decree Law 20/2011. In this way, provide a money measure of the change in welfare facing different groups of the population. Second, show the effect of income shifting (IS) on the welfare analysis of income taxation. For doing so, I estimate the ETI by Two-Stage Least Squares (2SLS) correcting for mean reversion, heterogeneous income trends and endogeneity bias. Based on these estimates, I determine the impact of the reform on tax revenue, well-being and efficiency. Furthermore, I explore the sensitivity of findings to income-shifting possibilities, variations in timing and different identification strategies. The data source for this exercise is a panel of tax returns from the Spanish Institute for Fiscal Studies over 2009-2014 period.

Chapter 3 has four main results. First, the elasticity estimates suggest that women are more responsive to tax changes than men. Moreover, I find that these estimates are quite sensitive to the length of the time-window over which the behavioral responses are observed, to capital gains and to the identification specification. Second, findings show that raising an extra euro of tax revenue entails substantial efficiency costs, especially in the year immediate to the reform. On average, for the entire population, the MCF is: 3.94 (in 2012), 2.47 (in 2013) and 1.88 (in 2014). In consequence, an important fraction of tax revenue is lost because of efficiency costs. At national level, the fraction of tax revenue lost through behavioral responses is approximately: 73% (in 2012), 58% (in 2013) and 46% (in 2014). Third, results indicate that the welfare loss from raising an additional euro of tax revenue is not the same for all Spanish taxpayers. In particular, I find that it is especially high for Catalan taxpayers and for self-employed individuals. Fourth, results show that welfare costs are quite sensitive to the introduction of IS responses. When I assume that half of income shifts from the general base to the savings base, the fraction of tax revenue lost due to behavioral responses drops from 73% to 52% (in 2012), from 58% to 41% (in 2013) and from 46% to 32% (in 2014).

The literature about the MCF is vast and diverse[3]. In the last decades, the literature has evidenced an increasing concern on this concept and on its application to different tax instruments and government expenditures[4]. Also, many incorporations have been made to the estimation of the MCF for a proper design of the tax system such as: distributional concerns, multiple-rate tax structures, tax bases' interaction, externalities and public expenditure[5]. In Spain, studies give rise to different

[3] The introduction of the concept of excess burden was in the 1960s and it was mainly verbal and descriptive. Empirical studies related to the MCF started with Harberger (1964) and Browning (1976). Nowadays, the literature is vast and much of it is fragmented because of the different measures used for the MCF such as marginal welfare cost, marginal excess burden, marginal efficiency cost and marginal deadweight loss (Dahlby 2008).

[4] Such as social security transfers (Bjertnaes, 2015), PIT, VAT and CIT (Dahlby and Ferede, 2018), grants (Dahlby and Ferede, 2016) and green taxes (Barrios *et al.* 2013).

[5] See: Giertz (2009), Blomquist and Simula (2010), Claus *et al.* (2012), Vasquez and Balistreri (2010), Chandoevwit and Dahlby (2007), Auriol and Warlters (2015).

measures and magnitudes of the MCF[6]. Indeed, there is no reason to expect a consensus value of the MCF as it depends on the particular reform examined and, most important, because it is remarkably responsive to the magnitude of the ETI.

Chapter 3 draws upon the broad literature of the MCF (for a deep review see Dahlby 2008), the recent income shifting literature (Devereux *et al.* 2014; Le Maire and Shjerning 2013; Harju and Matikka 2014) and the studies of the ETI (see Giertz 2009 and Saez *et al.* 2012 for an exhaustive review of the literature). In that sense, the contributions of this chapter to the literature are threefold. First, the tendency for the analysis of the MCF has been in the context of identical individuals and the top tax bracket (Creedy and Gemmell 2013). In this work, I use the MCF to evaluate the increase in all marginal tax rates that is imposed to heterogeneous individuals under a progressive tax. In this way, I illustrate how increases in tax rates are likely to be revenue-enhancing for some groups of the population. Second, studies usually distinguish between real responses and tax-motivated income shifting in the calculation of the ETI, but few analyze the implications of IS on well-being. As far as I am concerned, there is no empirical study about IS in Spain apart from a recent paper by López-Laborda *et al.* (2018). Providing new ETI estimates for Spain is the third contribution. The tax reform analyzed in this work was the most important tax modification done in the context of the 2008 economic crisis, with a significant impact on Spanish public finances. Therefore, as Sanz-Sanz (2016) claimed, the case of Spain is of interest in itself given the scarce studies on the evaluation of tax reforms.

The structure of this chapter is as follows. First, I present the basic theoretical framework in which I derive mathematically the ETI, the marginal revenue changes and the welfare changes caused by a tax modification. Then, I explain the empirical strategies used in the calculation of the main parameters. After this, I briefly describe the dual-income tax and the data used in the analysis. Finally, I present the main results and conclude.

3.2 Theoretical framework

The goal of this section is to develop the appropriate framework to analyze the deadweight burden caused by tax modifications. I begin with a brief review of the ETI; then, based on this parameter, I derive the analytical expressions needed for the quantification of the MCF.

[6] For instance, Alonso-Carrera and Manzano (2003) estimated a MCF of 1.26-1.32 for the period 1970-1994. A similar study done by Sancho (2003) obtained a MCF of about 1.50 for 1990. A more detailed study is provided by González-Páramo and Sanz-Sanz (2003) who estimated a MCF of 1.39 for married workers (1.11 for men and 1.92 for women) for the year 1999. Recently, Diaz and Onrubia (2018) found a MCF between 1.01-1.25 for the PIT reform of 2006.

3.2.1 Behavioral responses to taxation

As showed by Feldstein (1999), in the absence of income effects[7], the optimization of the utility function $u_i(c, z)$ with respect to the budget constraint $c = (1-\tau)z + \mu$ leads to the following reported income function: $z^* = z(1-\tau)^e$, where c is consumption, $(1-\tau)$ is the net-of-tax rate, μ denotes virtual income and z is reported income. Under this framework, consider a marginal change in $(1-\tau)$. By using the standard definition of substitution elasticity and the reported income function, the ETI is written as: $e = \frac{(1-\tau)}{z}\frac{dz}{d(1-\tau)}$ (Harju and Matikka 2014).

This behavioral elasticity calculates "the response of taxable income to a change in the marginal net-of-tax rate" (Creedy 2011, p. 271). But most important, through this reduced-form concept of the ETI, Feldstein (1995, 1999) contributed to "eliminate the need to construct and estimate a fully structural model with all taxpayers' behavioral responses", so that welfare measurements can be readily discussed and expressed explicitly in terms of the elasticity (Creedy 2013, p.1). Based on this, estimate the ETI is all I need for welfare analysis as it captures all individuals' responses to taxation – IS being one of them[8].

3.2.2 Marginal revenue changes

The Spanish PIT has two different tax bases: the general base (taxed by τ_g) and the savings base (taxed by τ_s), where $0 < \tau_s < \tau_g < 1$ (see Table B.1.1)[9]. In this context, it is reasonable to consider that the reduction in reported income in response to the 2011 tax reform was due in part to a shift away from the general base toward the savings base[10]. This hypothesis rests on two intuitions:

(a) The possibility of IS exists whenever there is another schedule where income is taxed at a lower tax rate. In these cases, taxpayers have tax opportunities for moving toward the tax base with a lower tax rate[11].

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[7] This assumption is common in the ETI literature because it simplifies considerably the analysis and because income effects are found to be non-statistically different from zero. See Arrazola *et al.* (2014) and Sanz-Sanz *et al.* (2015) for Spain, and Gruber and Saez (2002), Weber (2014) and Burns and Ziliak (2017) for U.S.

[8] However, this should be taken with caution in the presence of fiscal externalities. For instance, if IS exists and is important in the tax schedule, the ETI may overstate the efficiency costs of taxation because the reduction in reported income could be due to a shift away from one tax base to another also taxed (Harju and Matikka 2014). In this context, income shifting is not a full deadweight loss because it generates additional tax revenue. I will come back to this point in Section 3.5.

[9] This relation is valid for 2011-2014, except for 2012-2014 (tax bracket 1).

[10] The increase on the PIT rate could induce some taxpayers to leave the PIT schedule toward the corporate income tax or to informality. However, these two possibilities are out of our scope of study since the dataset covers only registered taxpayers reporting their individual tax returns.

[11] Usually, in structural models with IS – as in Piketty *et al.* (2013) – there is a cost for shifting income from one source to another. This work assumes this cost is non-significant or inexistent.

(b) The 2011 tax reform reinforced the IS incentives of taxpayers, as the difference between tax rates increased, especially for high-income earners (see Table B.1.1)[12]. Hence, I expect that a fraction of income disappears from the general base following the tax rate increase $d\tau_g$.

Based on these two intuitions, I extend the analysis of Sanz-Sanz (2016) to see the effect of the 2011 tax reform on tax revenue in the presence of IS possibilities. In the multi-rate structure of the Spanish PIT, the tax paid by an individual i with taxable income z_i is determined by a set of income thresholds $a_g, \dots, a_G$, marginal tax rates $\tau_g, \dots, \tau_G$ and non-genuine allowances m_g[13]. Let's suppose that the government increases all MTRs from the general tax base $d\tau_g$, while leaving income thresholds unchanged[14]. The effect on total revenue from a population of taxpayers caused by this increment, denoted MR_g, is determined as (Sanz-Sanz 2016, p. 46):

$$MR_g \equiv dR_g = \left[\left(\frac{dR_g}{d\tau_g} - \frac{d\theta}{d\tau_g}\right) + \left(\frac{dR_g}{dz_g} . \frac{dz_g}{d\tau_g}\right)\right] d\tau_g \tag{1}$$

Note that $d\tau_g$ induce two effects on tax revenue[15]. (i) The mechanical effect (first term in parenthesis), defined as "the projected increase in tax revenue, absent any behavioral response" (Saez *et al.* 2012, p. 7). This effect, in turn, depends on the impact of $d\tau_g$ on the tax due and on the tax savings derived from the entitle allowances (Sanz-Sanz 2016). (ii) The behavioral effect (second term in parenthesis), defined as the change in tax revenue due to behavioral responses. The decomposition of these two effects is crucial in the analysis of a tax modification because they move in opposite directions and together allow the calculation of the total revenue impact that would be expected from a tax modification (Arrazola *et al.* 2014). The total revenue paid by the g-th rate can be decomposed as[16]:

[12] Table B.1.1 shows that before the tax reform of 2011 the gap between the MTR for general income and that for savings ranged from 3 to 5 percentage points for the lowest-income earners, and from 26 to 28 percentage points for the richest. After the tax reform, this gap was reduced for the lowest-income earners (-2.25 to 3.75) and increased for the richest (27 to 33).

[13] Sanz-Sanz (2016, p.44) specifies the tax function as: $R_i = \tau_{g_i}\left[z_i - a'_{g_i}\right] - min\left[\tau_{m_i} \cdot \left(m_i - a'_{m_i}\right), R_i\right]$, where a'_{g_i} and a'_{m_i} denote the effective tax thresholds for z_i and m_i, respectively. Note that Sanz-Sanz differentiates genuine from non-genuine allowances because in the Spanish case the tax schedule is applied "to the personal and family allowances in order to subtract the obtained result from the derivative of applying the same tax schedule to taxpayer's gross income" (Sanz-Sanz 2016, p. 43).

[14] In fact, the 2011 tax reform increased the MTRs from both tax bases (general and savings). However, I ignore $d\tau_s$ assuming that the total revenue effect of responses from $d\tau_s$ are second order. Therefore, all the analytical expressions refer to the general base.

[15] A third effect is the adjustment of public expenditure (redistribution). For tractability, this study only takes efficiency considerations, no distributional issues. In other words, I assume governments' taste for redistribution is zero.

[16] See Sanz-Sanz (2016) for the complete derivation.

$$dR_g = \left\{\left[\left(\sum_{i=1}^{N_g} \frac{\partial R_i}{\partial \tau_g} + \sum_{l=1_g^+}^{N_g^+} \frac{\partial R_l}{\partial \tau_g}\right) - \left(\sum_{p=1_{m_g}}^{N_g^m} \frac{\partial \theta_p}{\partial \tau_g} + \sum_{q=1_{m_g}^+}^{N_g^{m^+}} \frac{\partial \theta_q}{\partial \tau_g}\right)\right] + \sum_{i=1_g}^{N_g} \left(\frac{\partial R_i}{\partial z_i} . \frac{\partial z_i}{\partial \tau_g}\right)\right\} d\tau_g \qquad (2)$$

Which becomes:

$$dR_g = \left\{\left[\left((\bar{z}_g - a_g). N_g + (a_{g+1} - a_g). N_g^+\right) - \left((\bar{m}_g - a_g). N_g^m + (a_{g+1} - a_g). N_g^{m^+}\right)\right] - \left[\left(\frac{\tau_g - s\tau_s}{1-\tau_g}\right) \bar{e}_{z_{g,1-\tau_g}} . \bar{z}_g . N_g\right]\right\} . d\tau_g \qquad (3)$$

Where, N_g (N_g^m) is the number of taxpayers whose taxable income (allowances) falls within rage g, $N_g^+(N_g^{m^+})$ is the number of taxpayers with taxable income (allowances) above a_{g+1}, $\bar{z}_g$ ($\bar{m}_g$) is the arithmetic mean of taxable income (allowances) falling within g, s is the fraction of income that shifted from the general base to the savings base[17], τ_s is the average tax rate from the savings base at which the shifted income is taxed and $\bar{e}_{z_{g,1-\tau_g}}$ is the average elasticity in bracket g – weighted by individual income[18].

3.2.3 Marginal welfare changes

The decomposition of the mechanical effect (ME) and the behavioral effect (BE) is important not only because it shed lights on the revenue impact of a tax change, but also because it allows the calculation of the well-being and the efficiency effects of the tax change (Arrazola *et al.* 2014). Because the behavioral responses to a tax change creates no additional welfare loss, the value of the ME approximates to the utility loss (measured in monetary terms) – known as the Equivalent Variation. See Section 3.A for the analytical derivation of this approximation. Hence, the BE roughly quantifies the variation in the deadweight loss or "the burden imposed on the taxpayer at the margin", called the marginal excess burden (Slemrod and Yitzhaki 1996, p. 185). Consequently, the marginal welfare cost (MWC) of a given tax change, defined as the ratio between the marginal excess burden and the revenue variation is given by[19]:

[17] Note that s is not the fraction of *total* taxable income that is taxed at τ_s, instead it is the fraction of general base taxable income (z_g).

[18] Two observations with respect to Eq. (3). First, as in most of the literature, I assume that all individuals in a given tax bracket have the same elasticity. Second, I assume that behavioral effects do not affect average tax rates. By doing so, "behavioral effects are confined to taxpayers in the corresponding tax bracket", while "mechanical ones are spread forward" through effective tax thresholds (Sanz-Sanz 2016, p. 49).

[19] This expression is only relevant when ME>BE, because it means that the tax rate is below the tax rate that would maximize tax revenue (i.e. the Laffer tax rate). So, there is still room for raising tax revenue ($MR_g > 0$).

$$MWC_g = \frac{MEB_g}{MR_g} = \frac{BE_g}{[ME_g - BE_g]} \tag{4}$$

The MWC_g measures the change in well-being per euro of extra tax revenue resulting from a tax rate modification. Based on this expression, the MCF is calculated as[20]: $MCF_g = 1 + MWC_g$.

The advantage of working with microdata is that most of the parameters needed in the calculation of the marginal excess burden are relatively straightforward to measure. So that, τ_s and $\bar{e}_{z_{g,1-\tau_g}}$ are the only two parameters necessary in the computation of the MCF_g. The former is readily calculated assuming that s take the following values: $0, 0.1, 0.3, 0.5$. However, the estimation of the elasticity is more complex and is explained in the next section.

3.3 Empirical methodology

In this section I set up a simple model, formally laid out in Gruber and Saez (2002), for the estimation of the elasticity. Also, I characterize the main econometric issues that underlines the estimation and explain the strategies of identification followed to get consistent estimates.

3.3.1 Regression specification

I regress the change in log annual taxable income on the change in the log net-of-tax rate, conditional on some function of base-year income to control for possible mean reversion, and on further demographic controls to capture changes in reported income not caused by the tax change[21]:

$$\Delta \log z_{it} = \beta_0 + \beta_1 \Delta \log(1 - \tau_{it}) + \beta_2 f(z_{it-1}) + \beta_3 X'_{it} + u_{it} \tag{5}$$

Where, Δ represents the difference in the variable between the year t and the base-year $t-1$. In this regression the individual ETI is represented by β_1, "it measures to what extent taxpayers respond to marginal incentives or, in other words, to what extent they generate less taxable income when facing a higher MTR" (Kiss and Mosberger 2015, p.886).

[20] The analytical expressions derived in this section are inevitably affected by the economic context. So, the impact of the economic cycle could be incorporated in the formulations developed above. A study on this matter can be found in Creedy and Sanz-Sanz (2010, 2011).

[21] These control variables include demographic variables (i.e. taxpayer's gender, marital status, age and age squared), household characteristics (i.e. type of tax return) and other variables, as taxpayer's main income source (i.e. whether taxpayers are self-employed, wage earners and capital owners).

The literature has identified two main problems with regard to the estimation of the ETI:

(a) The endogeneity problem: Given the existing endogeneity between reported income and the marginal tax rate, any estimation of Eq. (5) by OLS is biased. This problem is solved, as in much of the literature, using the instrumental variable (IV) estimation procedure. Therefore, Eq. (5) is estimated by Two-Stage Least Squares (2SLS) using as instrument the predicted tax rate (τ_{it}^{p}). To construct τ_{it}^{p}, I index all pre-reform taxable income with the corresponding CPI[22] that year and recalculate the corresponding amount as if the pre-reform indexed income would be taxed according to post-reform year regulations[23] (see Auten and Carroll 1999; Gruber and Saez 2002).

(b) The mean reversion problem: This phenomenon is caused by changes in income distribution and occurs when taxpayers experience high income in one year and then low income in the next, aside from any tax change. The possibility of mean reversion biases the estimates, so to rule out inconsistent estimates: (i) I introduce some function of base-year income $f(z_{it-1})$ as a control variable, (ii) I use additional demographic controls, and (iii) I eliminate the lowest-income individuals as mean reversion is usually more pronounced at the tails of the income distribution[24].

3.3.2 Identification strategies

There is a growing concern in the literature that the IV is not sufficiently exogenous as it depends on base-year income[25]. For this reason, several methods have been risen to overcome this potential threat of endogeneity in the IV. This study uses two methods, one proposed by Weber (2014) and the other by Gruber and Saez (2002). First, to construct the IV, I use lagged base-year income (2009, 2010) and exceptionally base-year income (2011). In this manner, as Weber (2014) argued, the IV is more exogenous to the error term. Different numbers of lags in the IV are also provided in Table C.2 to warrant the robustness of baseline results.

[22] CPI: 3.3% (2011), 1% (2010) and 0.8% (2009). Source: National Statistics Institute (INE).

[23] It is as if income does not change from $t-1$ to t, or as if taxpayers have their base-year income in both years and, in case of any change in income, it is solely due to inflation. Therefore, to calculate τ_{it}^{p} I assume *nothing* has change from $t-1$ to t, except inflation.

[24] I eliminate the individuals whose gross income pre-reform was below the Public Income Indicator of Multiple Effects (PIIME) which was 6 390.13 € (in 2011).

[25] Any shock to base-year income affects the IV and makes it correlated with the error term in the regression equation. Consequently, it does not satisfy one of the two requirements for an IV to be valid: (i) Relevance: $cov[\Delta\log(1-\tau_{it}), \Delta\log(1-\tau_{it}^{p}) | X'_{it}] > 0$, where X'_{it} is any other covariate included in the regression. (ii) Exogeneity: $cov[\Delta \log(1-\tau_{it}^{p}), u_{it}] = 0$. See: Weber (2014).

Second, to faced out the potential endogeneity in the IV, the income control $f(z_{it-1})$ takes the form of 10-piece splines in the lagged value of the dependent variable ($\Delta\, log\, z_{\mathrm{it-1}}$), exceptionally it takes the form of 20-piece splines in the logarithm of the base-year income ($log\, z_{\mathrm{it-1}}$). This income control serves the purpose of controlling for income shocks, especially for transitory shocks which seems to be serially correlated, according to Weber (2014). Other specifications are also provided in Table C.3 to assess the sensitivity of baseline results.

3.4 Institutional setting and data

3.4.1 The Personal income tax in Spain

The Spanish PIT has tree peculiarities that need to be taken into consideration in the analysis:

(a) Since 2007, it has two different bases, the general base and the savings base. Both taxed according to a progressive schedule. The general base is composed by six types of incomes: (1) labor, (2) economic activities, (3) movable capital (derived from intellectual and industrial property, technical assistance, renting of movable property, businesses or mines, subletting and leasing image rights), (4) immovable capital, (5) capital gains (not derived from the transfer of assets), and (6) income from special regimes and imputed income. On the other hand, the savings base has two components: movable capital (derived from dividends, interest, income from insurance and capitalization operations) and capital gains (derived from transmissions and reimbursements of assets).

(b) Since 2009, central and regional governments (ACs) can legislate over their PIT schedule, ACs have 50% of capacity over MTRs, deductions and tax bases. In the estimations, I take the tax rate and the income thresholds due by each taxpayer depending on his or her reported taxable income and Autonomous Community of residence. Therefore, the tax rate I use is a combination of the tax rates set by both governments (see Table B.1)[26].

(c) Since 2007, personal and family allowances take the form of tax credits, instead of tax deductions.

[26] It is not a combination of τ_g and τ_s because IS force the distinction between the tax rate from the recipient tax base (τ_s) and the tax rate from the sender tax base (τ_g).

The Spanish PIT change constantly, but the most recent tax reform for which panel data is available is the Royal-Decree Law 20/2011, in force since January 2012. The reform raised MTRs substantially in both tax bases and introduced an additional tax bracket at the top while leaving the rest of income thresholds unchanged[27]. For this reason, it “provides a useful natural experiment for studying the responsiveness of taxpayers to changes in MTRs” (Claus *et al.* 2012, p.6). Table B.1 provides a general overview of the reform.

3.4.2 Data

I use a balanced panel dataset compiled by the Tax Agency and the Spanish Institute for Fiscal Studies corresponding to the period 2009-2014. This period was chosen “for methodological reasons related to the need to identify two moments in time during which an exogenous change in tax rates occurred” (Arrazola *et al.* 2014, p.5) and the need to have some years previous the reform to run strategies of identification in the estimation of the ETI.

The database consists of 240 943 tax returns with detailed information about reported income, tax due and socio-economic characteristics from the principal taxpayer. The distribution of taxpayers and taxable income is reported in Table B.2. I restrict the estimation sample as follows. Navarre and Basque Country are not included in the original dataset as I only have information from the so-called Common Regime ACs. I exclude individuals under 16 years old and above 65 years old in order to consider taxpayers at working age and non-pensioners. Finally, the sample only includes taxpayers with a positive taxable income in 2009-2014[28].

3.4.3 Descriptive statistics

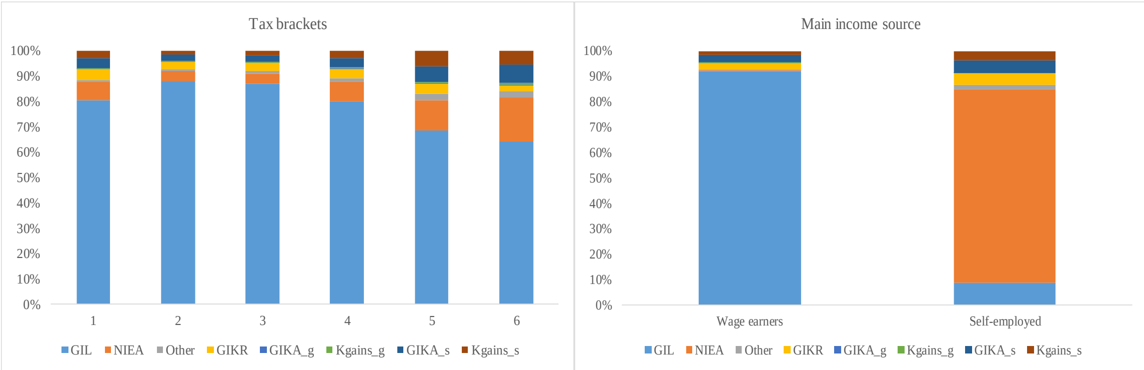
In this subsection I show two potential evidences of IS in the PIT schedule. Fig. 3.1 displays the size of the various components of gross income by tax brackets and by main income source. It shows that the shares of capital gains and movable capital (both from the savings base) increase with taxpayers’ income suggesting that high-income earners are more likely to shift income than low-income earners. The same happens for self-employed individuals. One explanation for this is that self-employed individuals and high-income earners have easier access to differently tax bases and

[27] This increase was uniform for all ACs; however, simultaneously certain ACs modified their regional marginal tax rates (e.g. Madrid, Andalusia, Asturias, Canary Islands, Cantabria, Castile-La Mancha, Extremadura, Murcia and Valence) and income thresholds (e.g. Andalusia, Asturias, Extremadura and Valence). All these modifications are taken into account in the estimation of the ETI (see Table B.1).

[28] I do not exclude taxpayers whose marital status or AC of residence change from $t-1$ to t as they represent only 2% and 1%, respectively. I do not exclude capital gains neither because it is the most likely channel for IS.

thus, can more readily manipulate the composition of their income through e.g. asset allocation decisions (see Seim 2017).

Figure 3.1: Income share and composition, in 2011-2014 (in %)



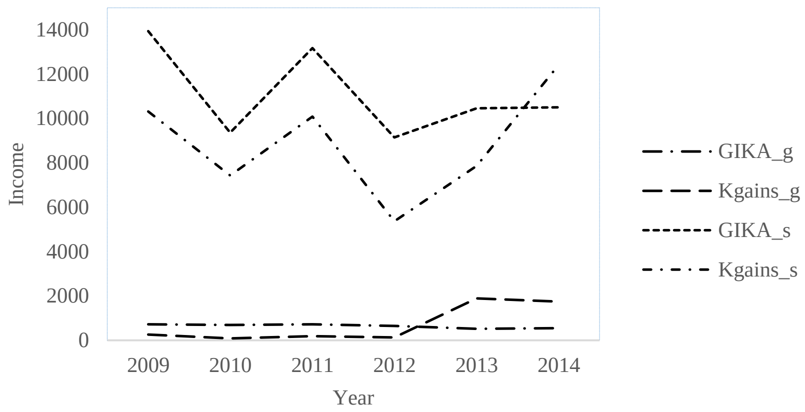
Notes: Fig. 3.1 divides total income into eight income components: labor (GIL), economic activities (NIEA), other (income from special regimes and imputed income), movable capital in the general base (GIKA_g), immovable capital (GIKR), capital gains in the general base (Kgains_g), capital gains in the savings base (Kgains_s) and movable capital in the savings base (GIKA_s).

Fig. 3.2 shows the evolution over time of capital gains and movable capital for top tax brackets. Capital gains and movable capital from the savings base display a similar path: a peak in 2011, followed by a fall and a recovery since 2012. However, for movable capital, the recovery was more moderate than for capital gains which display a steep rise from 2012 onwards. On the contrary, for the general base, I only detect fluctuations on capital gains after 2012[29]. A short glance to capital gains and movable capital postulates these two incomes as the most likely channels for IS in the PIT schedule[30].

[29] This could be because “in 2013 and 2014, capital gains generated in less than a year (in the savings base) reverted to forming part of the general taxable base” (Laborda *et al.* 2018, p.102).

[30] Indeed, López-Laborda *et al.* (2018) found evidence that Spanish personal income taxpayers –especially the highest-income individuals and the self-employed – shift part of their revenues from the general base to that of savings through movable assets and capital gains.

Figure 3.2: Evolution of movable capital and capital gains, in 2009-2014 (mean, in euros)



Notes: Fig. 3.2 shows income from capital gains in the general base (Kgains_g), movable capital in the general base (GIKA_g), capital gains in the savings base (Kgains_s) and movable capital in the savings base (GIKA_s). For taxpayers with general taxable income between [100 000-300 000] euros.

3.5 Results

3.5.1 Elasticity of taxable income

In order to have some variation to exploit in the estimation of the ETI, I group taxpayers in two categories (region and gender)[31]. Table 3.1 provides empirical estimates of Eq. (5). The predicted tax rate instrument is constructed from income lagged two periods prior the base-year in all cases, except for region 5 where it is a function of the log base-income. As noted by Weber (2014), the use of an appropriate lag is relevant in the construction of the instrument. In addition, a full set of socio-economic characteristics (age, age squared, type of tax return and main income source) are included in each regression. Finally, all estimates are weighted by taxpayers' income and standard errors are cluster by taxpayers' marital status.

Table 3.1 reports elasticities of taxable income for five regions, separately for men and women. My preferred baseline ETI estimates are in Columns (2)[32]. These estimates indicate that women are more responsive to marginal tax rate changes than men, except for regions 1 and 5. This is an expected outcome as, in Spain, women are more likely to be second or part-time earners within households, and thus have more flexibility in hours' choice and earnings decisions. This result

[31] Region 1 (Asturias, Cantabria, La Rioja, Aragon, Galicia, Ceuta, Melilla, Canary Islands, Castile-Leon), Region 2 (Andalusia and Extremadura), Region 3 (Balearic Islands and Catalonia), Region 4 (Madrid and Castile-La Mancha) and Region 5 (Valence and Murcia). Apart from Region 1, the rest were pooled together based on their geographic proximity.

[32] I prefer these estimates over those in Columns (1) and (3), given that they have more cases of significance.

coincides with Blomquist and Selin (2010) for Sweden, and Badenes (2001), Díaz and Onrubia (2018) and Arrazola *et al*. (2014) for Spain. All the first-stage F-statistics are above 60, indicating that instruments are not weak. Coefficients are statistically significant at the 1% level (with few exceptions).

The period of time considered in this study (2009-2014) allows to explore the sensitivity of findings to the length of the time-window over which the behavioral responses are observed. In Table 3.1, I compare ETI estimates based on one-, two-, and three-year differences to see if taxpayers' responses become stronger or weaker in the course of time. The estimates in Columns (2) are the benchmark results and assume responses take two periods, in Columns (1) and (3) this assumption is relaxed to one and three periods, respectively. The estimates are all significant (with few exceptions) and suggest that behavioral responses somewhat decrease over time[33]. In other words, this finding shows that Spanish taxpayers – in particular, women – can rapidly adapt their compliance behavior to tax modifications.

Finally, I estimate several specifications of Eq. (5) in order to assess the sensitivity of baseline results. These results are presented in Tables C.1-C.3. Table C.1 shows that the ETI is more sensitive to capital gains than to movable capital. Given that baseline estimates (Columns 1) change more when I drop individuals with capital gains (Columns 3) than when I drop individuals with movable capital (Columns 2). This result suggests that capital gains may be an important channel for IS in the Spanish PIT, in line with the study of López-Laborda *et al.* (2018). In Table C.2 identification appears to be sensitive to the number of lags used in the construction of the IV; whereas, in Table C.3 estimates are insensitive to the number of splines used in the income control, except for region 5.

[33] Except for region 1 (men), region 4 (women) and region 5 (men and women) where estimates increase with a broader time-window.

Table 3.1: Elasticity of taxable income [a]

	Region 1			Region 2			Region 3			Region 4			Region 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Women	1.30***	0.68***	0.41***	1.13**	0.90***	1.02	1.63***	1.35***	1.24***	1.11***	1.22***	0.52***	0.4	1.16	2.25***
	(0.03)	(0.13)	(0.15)	(0.53)	(0.29)	(0.64)	(0.19)	(0.39)	(0.21)	(0.03)	(0.09)	(0.19)	(0.78)	(1.13)	(0.72)
Men	1.69***	1.99***	1.87***	1.03***	0.77***	0.48***	0.67***	0.42***	0.22***	0.84***	0.16*	0.13	0.35	0.83***	0.75***
	(0.13)	(0.23)	(0.16)	(0.09)	(0.02)	(0.08)	(0.19)	(0.15)	(0.05)	(0.06)	(0.10)	(0.18)	(0.33)	(0.19)	(0.19)
Difference length	1 year	2 years	3 years	1 year	2 years	3 years	1 year	2 years	3 years	1 year	2 years	3 years	1 year	2 years	3 years
Spline included [b]	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	20-Piece	20-Piece	20-Piece
Instruments lags [c]	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0
First stage Partial R^2:															
Women	0.03	0.05	0.05	0.04	0.05	0.05	0.04	0.03	0.03	0.04	0.04	0.04	0.01	0.01	0.01
Men	0.04	0.04	0.04	0.05	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.04	0.03	0.02	0.02
First stage F-statistic:															
Women	964	329	359	80	170	62	1378	255	183	5131	33027	109154	827	1069	384
Men	1412	1739	13830	1272	288	1214	2006	11488	94826	1218	795	2198	91	91	258
Observations:															
Women	20284	20204	20016	13510	13468	13336	19048	19000	18899	21145	21067	20925	10008	9973	9907
Men	36739	36591	36357	28370	28277	28104	32267	32189	32047	37235	37054	36820	19085	19016	18914

Notes: 2SLS regressions based on Eq. (5) for one -year difference (Columns 1), two -year difference (Columns 2) and three-year difference (Columns 3). Heteroskedasticity-robust standard errors clustered by marital status are in parentheses. Indicator variables for type of tax return, main income source and age are also included in estimation (all in base-year). Significance levels are *** p<0.01, ** p<0.05, * p<0.1.

a Region 1 (Asturias, Cantabria, La Rioja, Aragon, Galicia, Ceuta, Melilla, Canary Islands, Castile-Leon), Region 2 (Andalusia and Extremadura), Region 3 (Balearic Islands and Catalonia), Region 4 (Madrid and Castile-La Mancha) and Region 5 (Valence and Murcia).

b I use a 10-piece spline on $\Delta \, log \, z_{2011}$, except for region 5 where I use a 20-piece spline on $log \, z_{2011}$.

c This row lists the number of lags used in the construction of the predicted tax rate instrument.

3.5.2 Revenue impact, well-being and efficiency

The estimation of the individual elasticity allows to study the impact of the tax reform on revenue, well-being and efficiency. For doing so, I use the estimates of Table 3.1 and the analytical expressions derived in Section 3.2. Moreover, I take 2011 as based-year and run the simulations comparing 2011 (pre-reform year) and 2012, 2013, 2014 (post-reform years), under alternative assumptions about the value of s. Main results are in Tables 3.2-3.6 for the whole population, for Catalonia, for Madrid, for self-employed individuals and for wage earners. In Tables D.1-D.4, I show additional computations for specific groups of the population according to their marital status and age[34].

(a) Without income shifting: $s = 0$

On average, for the entire population, the MCF is found to be 3.94 (for 2012), 2.47 (for 2013) and 1.88 (for 2014), see Table 3.2. Hence, for every extra euro of revenue arising from an increase in all MTRs, the marginal excess burden is €2.94 (in 2012), €1.47 (in 2013) and €0.88 (in 2014). This result indicates an important efficiency effect of the 2011 tax reform, especially in the year immediately after the tax modification. Indeed, MCFs decrease as the difference time-window increase, which suggest that behavioral responses are more substantial in 2012 than in the subsequent years. Consequently, an important fraction of tax revenue is lost because of efficiency costs. As can be seen in Table 3.2 (BE/ME), around 73% of the mechanical revenue gains are lost in 2012 due to inefficiencies created by the increased marginal tax burden. However, this lost decreases over time, it is around 58% in 2013 and around 46% in 2014.

Looking this result in more detail, gives rise to important differences on welfare effects depending on individuals' socio-economic characteristics. Tables 3.3 and 3.4 show that, on average, efficiency losses are more substantial in Catalonia than in Madrid: 3.69 vs. 2.86 (in 2012), 2.09 vs. 1.61 (in 2013) and 1.64 vs. 1.15 (in 2014). Similarly, in Tables 3.5 and 3.6 the rise of an additional euro of tax revenue is, on average, more costly for self-employed individuals than for wage earners: 4.38 vs. 3.89 (in 2012), 3.06 vs. 2.39 (in 2013) and 2.30 vs. 1.82 (in 2014)[35]. Consequently, on average, the fraction of tax revenue lost through behavioral responses (BE/ME) is higher in Catalonia than in Madrid (see Tables 3.3 and 3.4): 71% vs. 63% (in 2012), 52% vs. 38% (in 2013) and 38% vs. 13%

[34] When I compute the MCF for Catalonia and Madrid, I use the MTRs and the income thresholds from Tables B.1.2 and B.1.3. For the rest, since computation is at national level I work with the MTRs and the income thresholds from Table B.1.1. Moreover, I define wage earners (self-employed) as taxpayers whose main income source is labor (economic activities).

[35] MCFs are slightly higher for taxpayers above 45 years old than for those under 45 years old: 3.95 vs. 4.15 (in 2012), 2.51 vs. 2.47 (in 2013) and 1.91 vs. 1.84 (in 2014), see Tables D.3 and D.4. For married and non-married individuals there is not much difference: 4.04 vs. 4.29 (in 2012), 2.55 vs. 2.54 (in 2013) and 1.91 vs. 1.92 (in 2014), see Tables D.1 and D.2.

(in 2014). Likewise, this fraction is on average higher for self-employed individuals than for wage earners (see Tables 3.5 and 3.6)[36]: 75% vs. 72% (in 2012), 66% vs. 57% (in 2013) and 56% vs. 44% (in 2014). Note that the groups with higher MCFs are usually the most responsive taxpayers to changes in MTRs. Accordingly, Catalonia was found by Arrazola *et al.* (2014) as one of the regions with the largest elasticity – even above Madrid. As well, the self-employed are the group in the population with more possibilities to adjust taxable income to changes in tax rates.

Finally, when I compare tax brackets (in Table 3.2), I see that utility losses are higher in tax brackets 1 and 4 than in the rest; whereas, tax bracket 2 reports the smallest MCF. This result cannot be generalized to all groups, which suggest that increases in tax rates are not necessarily revenue-enhancing in all tax brackets.

(b) With income shifting: $s = 0.1, 0.3, 0.5$

When introducing IS possibilities I observe that MCFs get smaller as the fraction of income shifted (s) increases. In Table 3.2, on average, MCFs decrease in 14%, 36% and 52% when s takes the values of 0.1, 0.3 and 0.5, respectively. When I look in more detail, I see that in Madrid the introduction of IS possibilities does not reduce MCFs as much as in the rest of the groups, see Table 3.4. The opposite happens for self-employed individuals (see Table 3.5). This result shows the sensitivity of welfare costs to the value of s.

Note that with the introduction of s behavioral responses erase less of the mechanical revenue gain, around 6% less (when s=0.1), 18% less (when s=0.3) and 29% less (when s=0.5), see Table 3.2. This is so, because when I assume that 10%, 30% and 50% of income from the general base shift to the savings base I need to consider the fact that the shifted income is also taxed. As a result, the tax revenue from savings increases and offsets part of the loss in revenue on the general base, reducing the efficiency costs of taxation. Consequently, the standard ETI may overestimate the marginal excess burden because it assumes income shifting as a full DWL[37].

All in all, for each additional euro of taxes raised, the government imposed an extra cost which is especially high for Catalan taxpayers and self-employed individuals (compared to taxpayers from Madrid and wage earners). More important, findings indicate substantial efficiency costs of raising

[36] For the rest (married, non-married, under45 and above 45) I do not observe substantial differences between groups. See: Tables D.1-D.4.

[37] This result is in line with recent contributions (Doerrenberg *et al.* 2017; Claus *et al.* 2012; Saez *et al.* 2012; Harju and Matikka 2014) that have shed light on the limitations of the ETI as a sufficient statistic for welfare analysis in the presence of fiscal externalities.

an extra euro of revenue in the year immediate to the tax reform. Finally, results show that revenue losses get smaller when I assume the existence of IS responses[38].

Table 3.2: National level

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.74	0.66	0.56	3.90	2.91	2.25
	0.1	0.68	0.60	0.51	3.17	2.53	2.05
	0.3	0.57	0.50	0.42	2.31	2.00	1.74
	0.5	0.45	0.40	0.34	1.82	1.66	1.51
2	0	0.55	0.49	0.40	2.24	1.95	1.67
	0.1	0.52	0.45	0.38	2.06	1.83	1.60
	0.3	0.43	0.38	0.31	1.75	1.61	1.45
	0.5	0.35	0.30	0.25	1.53	1.44	1.34
3	0	0.71	0.61	0.49	3.42	2.55	1.96
	0.1	0.67	0.58	0.46	3.04	2.36	1.87
	0.3	0.59	0.50	0.41	2.42	2.02	1.68
	0.5	0.51	0.44	0.35	2.03	1.77	1.54
4	0	0.80	0.66	0.52	4.95	2.97	2.07
	0.1	0.76	0.63	0.49	4.15	2.71	1.97
	0.3	0.68	0.57	0.44	3.14	2.31	1.79
	0.5	0.60	0.50	0.39	2.52	2.01	1.64
5	0	0.77	0.57	0.41	4.36	2.30	1.71
	0.1	0.73	0.54	0.39	3.77	2.17	1.65
	0.3	0.66	0.49	0.36	2.97	1.95	1.55
	0.5	0.59	0.43	0.32	2.44	1.77	1.46
6	0	0.79	0.53	0.37	4.75	2.11	1.59
	0.1	0.75	0.50	0.35	4.07	2.01	1.55
	0.3	0.68	0.46	0.32	3.16	1.84	1.47
	0.5	0.61	0.41	0.29	2.59	1.69	1.41
Mean	0	0.73	0.58	0.46	3.94	2.47	1.88
	0.1	0.69	0.55	0.43	3.38	2.27	1.78
	0.3	0.60	0.48	0.38	2.62	1.95	1.61
	0.5	0.52	0.41	0.32	2.15	1.72	1.48

[38] Bear in mind that I can compute the MCF because ME>BE in all cases.

Table 3.3: Catalonia

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.77	0.59	0.49	4.37	2.45	1.95
	0.1	0.71	0.55	0.45	3.45	2.20	1.81
	0.3	0.59	0.45	0.37	2.43	1.82	1.59
	0.5	0.47	0.36	0.29	1.87	1.56	1.42
2	0	0.56	0.42	0.34	2.27	1.73	1.50
	0.1	0.52	0.39	0.31	2.09	1.65	1.46
	0.3	0.43	0.33	0.26	1.77	1.48	1.35
	0.5	0.35	0.26	0.21	1.54	1.36	1.27
3	0	0.70	0.52	0.40	3.34	2.08	1.68
	0.1	0.66	0.49	0.38	2.98	1.97	1.62
	0.3	0.58	0.43	0.34	2.39	1.76	1.50
	0.5	0.50	0.37	0.29	2.01	1.59	1.41
4	0	0.75	0.54	0.39	3.98	2.16	1.64
	0.1	0.71	0.51	0.37	3.47	2.04	1.59
	0.3	0.64	0.46	0.33	2.77	1.84	1.50
	0.5	0.57	0.41	0.30	2.30	1.68	1.42
5	0	0.73	0.50	0.34	3.70	2.01	1.51
	0.1	0.70	0.48	0.32	3.29	1.92	1.48
	0.3	0.63	0.43	0.29	2.70	1.77	1.41
	0.5	0.56	0.39	0.26	2.29	1.63	1.35
6	0	0.78	0.53	0.35	4.47	2.12	1.53
	0.1	0.74	0.51	0.33	3.89	2.02	1.50
	0.3	0.68	0.46	0.30	3.09	1.85	1.43
	0.5	0.61	0.41	0.27	2.56	1.71	1.37
Mean	0	0.71	0.52	0.38	3.69	2.09	1.64
	0.1	0.67	0.49	0.36	3.20	1.97	1.58
	0.3	0.59	0.43	0.32	2.52	1.75	1.47
	0.5	0.51	0.37	0.27	2.10	1.59	1.37

Table 3.4: Madrid

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.64	0.44	0.17	2.80	1.79	1.20
	0.1	0.59	0.41	0.15	2.44	1.69	1.18
	0.3	0.49	0.34	0.13	1.95	1.50	1.14
	0.5	0.38	0.26	0.10	1.62	1.36	1.11
2	0	0.50	0.32	0.12	2.00	1.48	1.14
	0.1	0.47	0.30	0.11	1.87	1.43	1.13
	0.3	0.39	0.25	0.09	1.63	1.33	1.10
	0.5	0.31	0.20	0.07	1.45	1.25	1.08
3	0	0.65	0.39	0.14	2.88	1.63	1.16
	0.1	0.62	0.37	0.13	2.62	1.58	1.15
	0.3	0.54	0.32	0.11	2.18	1.47	1.13
	0.5	0.47	0.28	0.10	1.87	1.38	1.11
4	0	0.73	0.35	0.11	3.75	1.54	1.12
	0.1	0.70	0.33	0.10	3.31	1.50	1.12
	0.3	0.63	0.30	0.09	2.67	1.43	1.10
	0.5	0.55	0.26	0.08	2.24	1.36	1.09
Mean	0	0.63	0.38	0.13	2.86	1.61	1.15
	0.1	0.59	0.35	0.12	2.56	1.55	1.14
	0.3	0.51	0.30	0.11	2.11	1.43	1.12
	0.5	0.43	0.25	0.09	1.80	1.34	1.10

Table 3.5: Self-employed

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.81	0.73	0.60	5.21	3.75	2.50
	0.1	0.74	0.68	0.55	3.91	3.08	2.23
	0.3	0.62	0.56	0.46	2.61	2.27	1.84
	0.5	0.49	0.44	0.36	1.95	1.80	1.57
2	0	0.56	0.51	0.42	2.26	2.04	1.73
	0.1	0.52	0.47	0.39	2.08	1.90	1.65
	0.3	0.43	0.39	0.33	1.76	1.65	1.48
	0.5	0.35	0.32	0.26	1.53	1.47	1.36
3	0	0.71	0.64	0.52	3.49	2.74	2.07
	0.1	0.68	0.60	0.49	3.09	2.52	1.97
	0.3	0.59	0.53	0.43	2.45	2.11	1.75
	0.5	0.51	0.46	0.37	2.04	1.83	1.59
4	0	0.81	0.72	0.60	5.25	3.52	2.53
	0.1	0.77	0.68	0.58	4.35	3.14	2.36
	0.3	0.69	0.61	0.52	3.24	2.57	2.07
	0.5	0.61	0.54	0.46	2.58	2.18	1.84
5	0	0.81	0.71	0.63	5.36	3.41	2.73
	0.1	0.78	0.67	0.60	4.45	3.07	2.52
	0.3	0.70	0.61	0.54	3.33	2.55	2.20
	0.5	0.62	0.54	0.49	2.66	2.18	1.94
6	0	0.79	0.65	0.55	4.71	2.86	2.24
	0.1	0.75	0.62	0.53	4.04	2.64	2.13
	0.3	0.68	0.56	0.48	3.14	2.29	1.92
	0.5	0.61	0.51	0.43	2.57	2.02	1.76
Mean	0	0.75	0.66	0.56	4.38	3.06	2.30
	0.1	0.71	0.62	0.52	3.65	2.72	2.14
	0.3	0.62	0.54	0.46	2.75	2.24	1.88
	0.5	0.53	0.47	0.39	2.22	1.91	1.68

Table 3.6: Wage earners

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.73	0.65	0.55	3.75	2.82	2.21
	0.1	0.68	0.59	0.50	3.08	2.46	2.02
	0.3	0.56	0.49	0.42	2.27	1.97	1.72
	0.5	0.44	0.39	0.33	1.80	1.64	1.49
2	0	0.55	0.49	0.40	2.24	1.95	1.67
	0.1	0.52	0.45	0.38	2.06	1.83	1.60
	0.3	0.43	0.38	0.31	1.75	1.61	1.45
	0.5	0.35	0.30	0.25	1.53	1.44	1.34
3	0	0.71	0.61	0.49	3.42	2.55	1.96
	0.1	0.67	0.58	0.46	3.04	2.36	1.86
	0.3	0.59	0.50	0.41	2.42	2.02	1.68
	0.5	0.51	0.44	0.35	2.03	1.77	1.54
4	0	0.80	0.66	0.51	4.92	2.93	2.04
	0.1	0.76	0.63	0.49	4.13	2.68	1.95
	0.3	0.68	0.56	0.44	3.13	2.29	1.77
	0.5	0.60	0.50	0.39	2.51	1.99	1.63
5	0	0.76	0.53	0.37	4.17	2.13	1.58
	0.1	0.72	0.51	0.35	3.63	2.03	1.53
	0.3	0.65	0.46	0.31	2.89	1.84	1.46
	0.5	0.58	0.41	0.28	2.40	1.69	1.39
6	0	0.79	0.48	0.31	4.82	1.93	1.45
	0.1	0.76	0.46	0.30	4.12	1.86	1.42
	0.3	0.69	0.42	0.27	3.19	1.72	1.37
	0.5	0.62	0.38	0.24	2.60	1.60	1.32
Mean	0	0.72	0.57	0.44	3.89	2.39	1.82
	0.1	0.68	0.54	0.41	3.34	2.20	1.73
	0.3	0.60	0.47	0.36	2.61	1.91	1.58
	0.5	0.52	0.40	0.31	2.14	1.69	1.45

3.6 Conclusions

Chapter 3 provides estimates of two important concepts in public finance: the elasticity of taxable income and the marginal costs of public funds of income taxation. Both crucial in the tax design of any country. Knowing these two parameters allows a more accurate estimation of the costs of financing public expenditure (Feldstein 1996).

I estimate the elasticity of taxable income for Spain for the period 2009-2014. The estimated mean value of this key parameter in 2013 is 1.06 (for women) and 0.83 (for men), women being more sensitive to taxation than men. Interestingly, I find that the length of the time-window over which the behavioral responses are observed have a considerable effect on individuals' responses. In particular, results show that Spanish taxpayers react almost immediately to tax changes. On the basis of these estimated elasticities, the impact of the 2011 tax reform has been assessed. Results reveal that the welfare cost of raising an extra euro of tax revenue is found to be well in excess of a euro, especially in the year immediate to the tax reform. Moreover, results indicate important differences in welfare costs depending on individuals' socio-economic characteristics. It is more expensive to rise an additional euro of tax revenue in Catalonia than in Madrid, and among self-employed individuals than among wage earners. I also find that the introduction of s behavioral responses erase less of the mechanical revenue gain, around 6% less (when s=0.1), 18% less (when s=0.3) and 29% less (when s=0.5).

This empirical application has made evident the crucial role played by the ETI and IS responses in the evaluation of a tax reform Accordingly, from an applied point of view, these results are extremely useful because they shed lights on the design of tax policies and tax revenue forecasting. However, there are many questions yet to be answered. For instance, for a proper design of an optimal tax system it is relevant to consider more components of the cost of taxation as administrative costs, compliance costs, excess burden of tax evasion, avoidance costs (Slemrod and Yitzhaki 1996). Also, a more precise modelling of IS responses is necessary for an accurate analysis of the welfare losses of income taxation.

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Supplemental material Chapter 3

3.A Analytical derivation: First vs. Second Order Approximations[39]

Let's consider the excess burden EB from raising a tax by $\Delta\tau$, given the pre-existing tax τ:

$$MEB = EB(\tau + \Delta\tau) - EB(\tau) \tag{1}$$

Using a second-order Taylor expansion to $EB(\tau + \Delta\tau)$, Eq. (1) can be approximated to[40]:

$$MEB \simeq \frac{dEB}{d\tau}\Delta\tau + \frac{1}{2}\frac{d^2EB}{d\tau^2}(\Delta\tau)^2 \tag{2}$$

Mathematically, the first term is first-order in $\Delta\tau$ and the second term is second-order in $(\Delta\tau)^2$. Graphically, in Fig. A.1, the first term is the DWL represented by the rectangle C, "C is an approximation to the decline in the value of net output" (Dahlby 2008, p. 29). The second term is the surplus loss of workers and employees represented by the two small triangles A and B. The leakage in government revenue only captures the first-order term in Eq. (2).

Then, to get MEB I need to derive $\frac{dEB}{d\tau}$. The excess burden EB is defined as equivalent variation EV (i.e. the lump sum amount the individual is willing to pay to avoid the tax increment) minus tax revenue R: $EB(\tau) = EV - R = [e(\tau_2, U) - e(\tau_1, U)] - R$, where $(\tau_1, \tau_2) = (\tau, \tau + \Delta\tau)$, $R = z(\tau).\tau$ and $e(.)$ are expenditure functions (i.e. the minimum income agent requires to arrive a given level of utility for a given tax rate). Therefore, the MEB is rewritten as:

$$MEB \simeq \frac{dEB}{d\tau}\Delta\tau \simeq \left[\frac{dEV}{d\tau} - \frac{dR}{d\tau}\right]\Delta\tau \tag{3}$$

- $\frac{dR}{d\tau} = z + \tau\frac{\partial z}{\partial \tau}$

Note that, z is the predicted revenue gain assuming behavior does not change with the tax rate modification (i.e. ME) and $\tau\frac{\partial z}{\partial \tau}$ is the behavioral response (i.e. BE).

[39] This derivation is based on the Econ2450A Public Economics Lectures (Part 3: Efficiency Costs of Taxation) from Prof. Raj Chetty, Harvard University.

[40] The second-order Taylor expansion to $EB(\tau + \Delta\tau)$ is: $EB(\tau) + \frac{dEB}{d\tau}\Delta\tau + \frac{1}{2}\frac{d^2EB}{d\tau^2}(\Delta\tau)^2$.

- $\frac{dEV}{d\tau} = z$

  Proof: Shephard's Lemma (the Envelop theorem)[41]

$$\min_{(c,l)} e = c + z(1-\tau), \quad st: u(c,l) = \bar{u}$$

$$FOC: MRS \equiv \frac{u_l'(c,l)}{u_c'(c,l)} = (1-\tau)w$$

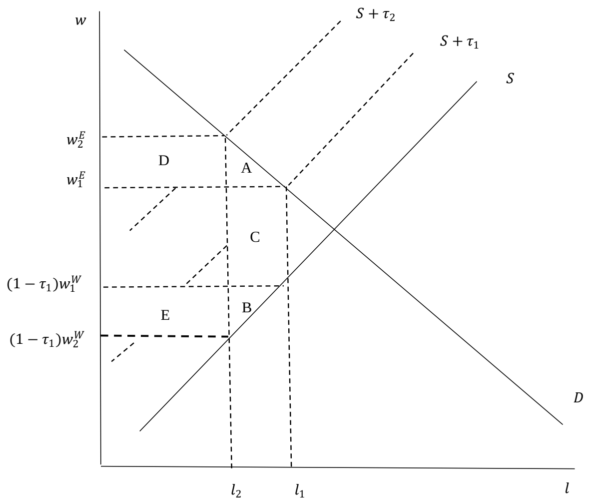
Where, $z = wl$. Using the FOC and differentiating the constraint from the minimization problem $u_c'(c,l).\frac{dc}{d\tau} + u_l'(c,l).\frac{dl}{d\tau} = 0$, the derivative of the expenditure function with respect to the tax is[42]: $\frac{de}{d\tau} = z$.

Therefore, the value of the ME approximates to $\frac{dEV}{d\tau}$. As a result,

$$MEB \simeq \left[\frac{dEV}{d\tau} - \frac{dR}{d\tau}\right]\Delta\tau \simeq \left[z - \left(z + \tau\frac{\partial z}{\partial \tau}\right)\right]\Delta\tau$$

$$\leftrightarrow MEB \simeq -\tau\frac{dz}{d\tau}\Delta\tau \qquad (4)$$

Figure A.1: Excess burden of a tax increase (Harberger's Trapezoid)[43]



[41] The Shepard's lemma is the mirror of the Envelop theorem. The latter maximizes initial utility given that marginal behavioral changes have no effect on utility, while the former minimizes initial expenditure given that marginal behavioral changes have no effect on expenditure.

[42] The FOC from this optimization problem generates Hicksian (or compensated) demand functions. Based on micro foundation, this derivation gives us a single-valued function for the size of the expenditure change EV required in the estimation.

[43] The rectangles E and D represent the burden of the tax increased that falls on workers and employees; in other words, are the tax revenue collected by the government.

3.B Descriptive statistics

Table B.1: Tax schedules pre- and post-reform (Central Government + Regional Government)

Table B.1.1: National

Taxable income (general base)		Marginal tax rates (%)		
Brackets	Nominal thresholds	2011	2012-2014	Δ (%)
1	0	0.24	0.2475	3.13
2	17 707	0.28	0.30	7.14
3	33 007	0.37	0.40	8.11
4	53 407	0.43	0.47	9.30
5	120 000	0.45	0.50	11.11
6	175 000	0.47	0.53	12.77
7	300 000	0.47	0.54	14.89
Taxable income (savings base)		**Marginal tax rates (%)**		
Brackets	Nominal thresholds	2011	2012-2014	Δ (%)
1	0	0.19	0.21	10.53
2	6 000	0.21	0.25	19.05
3	24 000	0.21	0.27	28.57

Note: The savings base's schedule at national level is the same at regional level.

Table B.1.2: Catalonia

Taxable income (general base)		Marginal tax rates (%)		
Brackets	Nominal thresholds	2011	2012-2014	Δ (%)
1	0	0.24	0.2475	3.13
2	17 707	0.28	0.30	7.14
3	33 007	0.37	0.40	8.11
4	53 407	0.43	0.47	9.30
5	120 000	0.46	0.51	10.87
6	175 000	0.49	0.55	12.24

Table B.1.3: Madrid

Taxable income (general base)		Marginal tax rates (%)				
Brackets	Nominal thresholds	2011	2012, 2013	2014	Δ 2012, 13 (%)	Δ 2012,14 (%)
1	0	0.236	0.2435	0.24	3.18	1.69
2	17 707	0.277	0.297	0.29	7.22	4.69
3	33 007	0.368	0.398	0.39	8.15	5.97
4	53 407	0.429	0.469	0.47	9.32	9.55

Table B.2: Distribution of taxpayers and taxable income

National (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	3468965	42%	4871669	58%	11261	2%
2	3012918	36%	1858751	22%	24131	4%
3	1343670	16%	515082	6%	40653	6%
4	480500	6%	34582	0.41%	72810	11%
5	23356	0.28%	11226	0.13%	142738	22%
6	11226	0.13%	0	0%	354628	55%

Catalonia (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	561258	35%	1024180	65%	11809	2%
2	621732	39%	402448	25%	24172	4%
3	283661	18%	118787	7%	40714	7%
4	106077	7%	12711	0.80%	73672	12%
5	7824	0.49%	4886	0.31%	142184	23%
6	4886	0.31%	0	0%	316889	52%

Madrid (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	492497	33%	1019816	67%	11794	6%
2	551068	36%	468748	31%	24257	13%
3	307685	20%	161063	11%	41151	23%
4	161063	11%	0	0%	104501	58%

Wage earners (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	2936120	39%	4530428	61%	11447	2%
2	2808022	38%	1722406	23%	24179	4%
3	1262545	17%	459861	6%	40593	6%
4	431884	6%	27977	0.37%	72535	11%
5	19211	0.26%	8766	0.12%	142688	22%
6	8766	0.12%	0	0%	343986	54%

Self-employed (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	266262	60%	176248	40%	10646	2%
2	104328	24%	71921	16%	23325	3%
3	40628	9%	31293	7%	41866	6%
4	27400	6%	3893	0.88%	76032	11%
5	2434	0.55%	1459	0.33%	143699	21%
6	1459	0.33%	0	0%	383480	56%

Non-married (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	1120171	42%	1521665	58%	11507	2%
2	1040376	39%	481289	18%	23960	4%
3	368846	14%	112443	4%	40434	7%
4	106112	4%	6331	0.24%	71250	12%
5	4545	0.17%	1786	0.07%	143298	23%
6	1786	0.07%	0	0%	319822	52%

Married (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	2204828	37%	3725241	63%	11097	2%
2	1840428	31%	1884813	32%	24232	4%
3	928839	16%	955974	16%	40738	6%
4	928839	16%	27135	0.46%	73237	11%
5	18152	0.31%	8983	0.15%	142545	22%
6	8983	0.15%	0	0%	361038	55%

Under45 (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	1788350	48%	1935221	52%	11481	2%
2	1435495	39%	499726	13%	23795	4%
3	386827	10%	112899	3%	40576	7%
4	107478	3%	5421	0.15%	71417	12%
5	3972	0.11%	1449	0.04%	142713	23%
6	1449	0.04%	0	0%	324971	53%

Above45 (General tax base)						
Pre-reform year 2011	Nh		Nh+		zh (mean)	
Bracket	Absolute number	(%)	Absolute number	(%)	Absolute number	(%)
1	1464019	36%	2629103	64%	10982	2%
2	1390402	34%	1238701	30%	24468	4%
3	868386	21%	370315	9%	40654	6%
4	343010	8%	27305	0.67%	73234	11%
5	18151	0.44%	9154	0.22%	142718	22%
6	9154	0.22%	0	0%	360220	55%

3.C Sensitivity analysis

Table C.1: Sensitivity analysis with respect to capital income [a]

	Region 1			Region 2			Region 3			Region 4			Region 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Women	0.68***	0.68***	0.71***	0.90***	0.98***	0.68**	1.35***	1.31***	1.27***	1.22***	1.19***	1.30***	1.16	1.17	0.85
	(0.13)	(0.15)	(0.14)	(0.29)	(0.20)	(0.31)	(0.39)	(0.32)	(0.32)	(0.09)	(0.00)	(0.10)	(1.13)	(1.19)	(1.05)
Men	1.99***	1.99***	2.11***	0.77***	0.92***	0.84***	0.42***	0.39*	0.25***	0.16*	0.10	0.24***	0.83***	0.70***	0.65*
	(0.23)	(0.22)	(0.30)	(0.02)	(0.01)	(0.03)	(0.15)	(0.20)	(0.03)	(0.10)	(0.09)	(0.03)	(0.19)	(0.16)	(0.34)
Difference length	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years
Spline included [b]	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	20-Piece	20-Piece	20-Piece
Instruments lags [c]	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0
First stage Partial R^2:															
Women	0.05	0.05	0.05	0.05	0.05	0.05	0.03	0.03	0.03	0.04	0.04	0.04	0.01	0.01	0.01
Men	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.02	0.02
First stage F-statistic:															
Women	329	211	729	170	308	95	255	213	256	33027	7848	1671	1069	2881	7365
Men	1739	1897	476	288	244	262	11488	156421	1290	795	773	8449	91	101	82
Observations:															
Women	20204	19707	17011	13468	13167	11600	19000	18606	16822	21067	20612	18261	9973	9767	8628
Men	36591	35392	30016	28277	27313	23438	32189	31176	27548	37054	35876	30871	19016	18459	16029

Notes: 2SLS regressions based on Eq. (5) for two-year difference. Heteroskedasticity-robust standard errors clustered by marital status are in parentheses. Indicator variables for type of tax return, main income source and age are also included in estimation (all in base-year). Significance levels are *** p<0.01, ** p<0.05, * p<0.1. Columns (1) repeat the baseline estimates of Table 3.1 as a benchmark. Columns (2) drop individuals with movable capital (general base) and Columns (3) drop individuals with capital gains (general base).

a Region 1 (Asturias, Cantabria, La Rioja, Aragon, Galicia, Ceuta, Melilla, Canary Islands, Castile-Leon), Region 2 (Andalusia and Extremadura), Region 3 (Balearic Islands and Catalonia), Region 4 (Madrid and Castile-La Mancha) and Region 5 (Valence and Murcia).

b I use a 10-piece spline on $\Delta\, log\, z_{2011}$, except for region 5 where I use a 20-piece spline on $log\, z_{2011}$.

c This row lists the number of lags used in the construction of the predicted tax rate instrument.

Table C.2: Sensitivity analysis with respect to the number of lags in the IV [a]

	Region 1			Region 2			Region 3			Region 4			Region 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Women	2.64***	2.31***	0.68***	3.38***	2.15***	0.90***	3.81***	3.70***	1.35***	2.35***	3.52***	1.22***	1.16	-3.09***	-3.33***
	(0.46)	(0.13)	(0.13)	(0.11)	(0.21)	(0.29)	(0.50)	(0.05)	(0.39)	(0.02)	(0.54)	(0.09)	(1.13)	(0.01)	(0.29)
Men	3.14***	5.46***	1.99***	2.17***	3.77***	0.77***	3.90***	3.73***	0.42***	3.78***	3.69***	0.16*	0.83***	-2.60***	-2.65***
	(0.35)	(0.25)	(0.23)	(0.01)	(0.17)	(0.02)	(0.33)	(0.24)	(0.15)	(0.25)	(0.05)	(0.10)	(0.19)	(0.10)	(0.21)
Difference length	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years
Spline included [b]	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	10-Piece	20-Piece	20-Piece	20-Piece
Instruments lags [c]	0	1	2	0	1	2	0	1	2	0	1	2	0	1	2
First stage Partial R^2:															
Women	0.04	0.06	0.05	0.02	0.06	0.05	0.02	0.04	0.03	0.04	0.05	0.04	0.01	0.04	0.04
Men	0.02	0.04	0.04	0.02	0.05	0.04	0.02	0.04	0.04	0.02	0.04	0.04	0.02	0.05	0.04
First stage F-statistic:															
Women	584	415	329	989	4759	170	2883	206	255	2.320e+07	657	33027	1069	69	44
Men	149	5781	1739	3106	337247	288	1192	67752	11488	598	1764	795	91	17481	6968
Observations:															
Women	20204	20204	20204	13468	13468	13468	19000	19000	19000	21067	21067	21067	9973	9973	9973
Men	36591	36591	36591	28277	28277	28277	32189	32189	32189	37054	37054	37054	19016	19016	19016

Notes: 2SLS regressions based on Eq. (5) for two-year difference. Heteroskedasticity-robust standard errors clustered by marital status are in parentheses. Indicator variables for type of tax return, main income source and age are also included in estimation (all in base-year). Significance levels are *** p<0.01, ** p<0.05, * p<0.1.

a Region 1 (Asturias, Cantabria, La Rioja, Aragon, Galicia, Ceuta, Melilla, Canary Islands, Castile-Leon), Region 2 (Andalusia and Extremadura), Region 3 (Balearic Islands and Catalonia), Region 4 (Madrid and Castile-La Mancha) and Region 5 (Valence and Murcia).

b I use a 10-piece spline on $\Delta \, log \, z_{2011}$, except for region 5 where I use a 20-piece spline on $log \, z_{2011}$.

c This row lists the number of lags used in the construction of the predicted tax rate instrument. Columns (3) repeat the baseline estimates of Table 3.1 as a benchmark, except for region 5 where Column (1) is the benchmark.

Table C.3: Sensitivity analysis with respect to the number of splines [a]

	Region 1			Region 2			Region 3			Region 4			Region 5		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Women	0.68***	0.68***	0.68***	0.90***	0.90***	0.90***	1.35***	1.35***	1.35***	1.21***	1.22***	1.21***	-5.23***	0.33	1.16
	(0.13)	(0.13)	(0.13)	(0.29)	(0.29)	(0.29)	(0.39)	(0.39)	(0.39)	(0.08)	(0.09)	(0.09)	(1.24)	(1.16)	(1.13)
Men	1.98***	1.99***	1.99***	0.77***	0.77***	0.77***	0.41***	0.42***	0.42***	0.16*	0.16*	0.16*	-8.06***	-0.38***	0.83***
	(0.23)	(0.23)	(0.23)	(0.02)	(0.02)	(0.02)	(0.15)	(0.15)	(0.15)	(0.10)	(0.10)	(0.10)	(0.16)	(0.08)	(0.19)
Difference length	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years	2 years
Spline included [b]	5-Piece	10-Piece	20-Piece	5-Piece	10-Piece	20-Piece	5-Piece	10-Piece	20-Piece	5-Piece	10-Piece	20-Piece	5-Piece	10-Piece	20-Piece
Instruments lags [c]	2	2	2	2	2	2	2	2	2	2	2	2	0	0	0
First stage Partial R^2:															
Women	0.05	0.05	0.05	0.05	0.05	0.05	0.03	0.03	0.03	0.04	0.04	0.04	0.01	0.09	0.01
Men	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.02	0.01	0.02
First stage F-statistic:															
Women	329	329	329	170	170	170	255	255	255	26135	33027	33027	279	72	1069
Men	1732	1739	1739	288	288	288	12189	11488	11488	794	795	795	80	74	91
Observations:															
Women	20204	20204	20204	13468	13468	13468	19000	19000	19000	21067	21067	21067	9973	9973	9973
Men	36591	36591	36591	28277	28277	28277	32189	32189	32189	37054	37054	37054	19016	19016	19016

Notes: 2SLS regressions based on Eq. (5) for two-year difference. Heteroskedasticity-robust standard errors clustered by marital status are in parentheses. Indicator variables for type of tax return, main income source and age are also included in estimation (all in base-year). Significance levels are *** p<0.01, ** p<0.05, * p<0.1.

a Region 1 (Asturias, Cantabria, La Rioja, Aragon, Galicia, Ceuta, Melilla, Canary Islands, Castile-Leon), Region 2 (Andalusia and Extremadura), Region 3 (Balearic Islands and Catalonia), Region 4 (Madrid and Castile-La Mancha) and Region 5 (Valence and Murcia).

b This row lists the number of pieces of splines used in the construction of the income control. Columns (2) repeat the baseline estimates of Table 3.1 as a benchmark, except for region 5 where Column (3) is the benchmark.

c This row lists the number of lags used in the construction of the predicted tax rate instrument.

3.D Additional estimations: revenue impact, well-being and efficiency

Table D.1: Married

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.80	0.72	0.60	5.05	3.52	2.51
	0.1	0.74	0.66	0.55	3.82	2.94	2.25
	0.3	0.61	0.55	0.46	2.57	2.20	1.85
	0.5	0.48	0.43	0.36	1.94	1.76	1.57
2	0	0.56	0.50	0.42	2.26	2.00	1.71
	0.1	0.52	0.47	0.39	2.09	1.87	1.63
	0.3	0.43	0.39	0.32	1.76	1.63	1.47
	0.5	0.35	0.31	0.26	1.54	1.45	1.35
3	0	0.71	0.61	0.50	3.41	2.59	1.98
	0.1	0.67	0.58	0.47	3.03	2.39	1.89
	0.3	0.59	0.51	0.41	2.42	2.04	1.70
	0.5	0.51	0.44	0.35	2.02	1.78	1.55
4	0	0.79	0.66	0.51	4.80	2.94	2.05
	0.1	0.75	0.63	0.49	4.05	2.68	1.95
	0.3	0.68	0.56	0.44	3.08	2.29	1.78
	0.5	0.60	0.50	0.39	2.49	1.99	1.63
5	0	0.76	0.55	0.40	4.12	2.22	1.66
	0.1	0.72	0.52	0.38	3.60	2.10	1.61
	0.3	0.65	0.47	0.34	2.87	1.89	1.52
	0.5	0.58	0.42	0.30	2.38	1.73	1.44
6	0	0.78	0.51	0.36	4.58	2.05	1.56
	0.1	0.75	0.49	0.34	3.95	1.96	1.52
	0.3	0.68	0.44	0.31	3.10	1.80	1.45
	0.5	0.61	0.40	0.28	2.55	1.66	1.38
Mean	0	0.73	0.59	0.46	4.04	2.55	1.91
	0.1	0.69	0.56	0.44	3.42	2.32	1.81
	0.3	0.61	0.49	0.38	2.63	1.98	1.63
	0.5	0.52	0.42	0.32	2.15	1.73	1.49

Table D.2: Non-married

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.66	0.58	0.50	2.98	2.36	1.99
	0.1	0.61	0.53	0.46	2.57	2.13	1.85
	0.3	0.51	0.44	0.38	2.03	1.79	1.61
	0.5	0.40	0.35	0.30	1.67	1.53	1.43
2	0	0.54	0.47	0.38	2.20	1.89	1.62
	0.1	0.51	0.44	0.36	2.03	1.78	1.56
	0.3	0.42	0.36	0.30	1.73	1.57	1.42
	0.5	0.34	0.29	0.24	1.52	1.42	1.32
3	0	0.71	0.60	0.48	3.46	2.48	1.91
	0.1	0.67	0.57	0.45	3.07	2.30	1.83
	0.3	0.59	0.49	0.40	2.44	1.98	1.65
	0.5	0.51	0.43	0.34	2.04	1.75	1.52
4	0	0.82	0.68	0.54	5.56	3.13	2.17
	0.1	0.78	0.65	0.51	4.55	2.84	2.06
	0.3	0.70	0.58	0.46	3.33	2.39	1.86
	0.5	0.62	0.51	0.41	2.63	2.06	1.69
5	0	0.83	0.65	0.50	5.74	2.86	2.01
	0.1	0.79	0.62	0.48	4.70	2.63	1.92
	0.3	0.71	0.56	0.43	3.45	2.27	1.76
	0.5	0.63	0.50	0.39	2.73	1.99	1.63
6	0	0.83	0.61	0.45	5.84	2.54	1.80
	0.1	0.79	0.58	0.43	4.80	2.38	1.74
	0.3	0.72	0.53	0.39	3.54	2.11	1.63
	0.5	0.64	0.47	0.35	2.81	1.89	1.53
Mean	0	0.73	0.60	0.47	4.29	2.54	1.92
	0.1	0.69	0.56	0.45	3.62	2.34	1.83
	0.3	0.61	0.49	0.39	2.75	2.02	1.66
	0.5	0.52	0.43	0.34	2.23	1.77	1.52

Table D.3: Above45

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.76	0.68	0.57	4.22	3.10	2.34
	0.1	0.70	0.62	0.53	3.36	2.66	2.12
	0.3	0.58	0.52	0.44	2.39	2.07	1.78
	0.5	0.46	0.41	0.35	1.86	1.69	1.53
2	0	0.56	0.50	0.41	2.25	1.98	1.69
	0.1	0.52	0.46	0.38	2.08	1.86	1.62
	0.3	0.43	0.38	0.32	1.76	1.62	1.46
	0.5	0.35	0.31	0.26	1.53	1.45	1.34
3	0	0.71	0.62	0.51	3.45	2.62	2.02
	0.1	0.67	0.59	0.48	3.06	2.42	1.92
	0.3	0.59	0.51	0.42	2.43	2.05	1.72
	0.5	0.51	0.44	0.36	2.03	1.79	1.57
4	0	0.80	0.67	0.53	4.89	3.03	2.13
	0.1	0.76	0.64	0.50	4.11	2.75	2.01
	0.3	0.68	0.57	0.45	3.12	2.33	1.82
	0.5	0.60	0.51	0.40	2.51	2.02	1.67
5	0	0.77	0.56	0.41	4.28	2.26	1.69
	0.1	0.73	0.53	0.39	3.71	2.14	1.64
	0.3	0.66	0.48	0.35	2.93	1.92	1.54
	0.5	0.59	0.43	0.31	2.42	1.75	1.46
6	0	0.78	0.52	0.36	4.58	2.07	1.57
	0.1	0.75	0.49	0.35	3.95	1.98	1.53
	0.3	0.68	0.45	0.32	3.09	1.81	1.46
	0.5	0.61	0.40	0.28	2.54	1.67	1.40
Mean	0	0.73	0.59	0.47	3.95	2.51	1.91
	0.1	0.69	0.56	0.44	3.38	2.30	1.81
	0.3	0.60	0.49	0.38	2.62	1.97	1.63
	0.5	0.52	0.42	0.33	2.15	1.73	1.49

Table D.4: Under45

Tax bracket	s	BE/ME			MCF		
		2012	2013	2014	2012	2013	2014
1	0	0.73	0.63	0.53	3.65	2.73	2.13
	0.1	0.67	0.58	0.49	3.02	2.40	1.96
	0.3	0.55	0.48	0.40	2.24	1.94	1.68
	0.5	0.44	0.38	0.32	1.78	1.62	1.47
2	0	0.55	0.48	0.39	2.21	1.92	1.65
	0.1	0.51	0.45	0.37	2.05	1.81	1.58
	0.3	0.43	0.37	0.30	1.74	1.59	1.44
	0.5	0.34	0.30	0.25	1.52	1.43	1.33
3	0	0.70	0.59	0.45	3.37	2.42	1.82
	0.1	0.67	0.56	0.43	3.00	2.26	1.75
	0.3	0.58	0.49	0.37	2.40	1.95	1.60
	0.5	0.50	0.42	0.32	2.01	1.73	1.48
4	0	0.80	0.65	0.48	5.13	2.82	1.92
	0.1	0.77	0.61	0.46	4.27	2.59	1.84
	0.3	0.69	0.55	0.41	3.19	2.23	1.69
	0.5	0.61	0.49	0.36	2.55	1.95	1.57
5	0	0.78	0.59	0.43	4.55	2.43	1.75
	0.1	0.74	0.56	0.41	3.90	2.28	1.69
	0.3	0.67	0.51	0.37	3.04	2.03	1.58
	0.5	0.60	0.45	0.33	2.49	1.82	1.49
6	0	0.83	0.60	0.44	6.00	2.48	1.77
	0.1	0.80	0.57	0.42	4.91	2.33	1.71
	0.3	0.72	0.52	0.38	3.59	2.07	1.60
	0.5	0.65	0.46	0.34	2.83	1.86	1.51
Mean	0	0.73	0.59	0.45	4.15	2.47	1.84
	0.1	0.69	0.56	0.43	3.52	2.28	1.75
	0.3	0.61	0.49	0.37	2.70	1.97	1.60
	0.5	0.52	0.42	0.32	2.20	1.74	1.47

Chapter 4

Evasion vs. Real production Responses to Taxation among Firms: Bunching Evidence from Argentina[1]

4.1 Introduction

In the last decades, globalization and market liberalization have exacerbated poverty and inequality in developing countries. As Besley and Persson (2013, p.2) claimed, "tax lies at the heart of state development"; as a result, according to the authors additional domestic revenue has become necessary in order to finance development and poverty reduction.

In Latin America, governments generally rely more on indirect taxation and resource revenue than on direct taxation. The Value Added Tax (VAT) and non-tax revenues are the primary sources of revenue collection[2]. The presence of large informal economies is in fact one of the causes of this dependence on indirect taxation; since it results in income tax revenue being insignificant and the tax base being highly concentrated in a few large firms[3]. Furthermore, the economic growth witnessed by Latin American countries over the last decade and half has given rise to an entrepreneurship spirit, leading to the creation of numerous small and medium enterprises (SMEs). In the literature of tax design, these enterprises are classified as a 'hard-to-tax' sector[4]. Although this sector represents an important contribution to the national economy, the tax revenue raised by it is very low, due to the large informality.

[1] I am grateful to Professor Jean Hindriks and Professor Romain Houssa for their advice and suggestions.

[2] Along 1990 and 2009, the revenue collected by the VAT was around half of the tax revenue in Argentina and the non-tax revenue was 12%. Based on the ICTD Government Revenue Dataset (ICTD GRD, 2014).

[3] According to Schneider *et al*. (2010), the shadow economy in Argentina during 1997-2007 represented 25.3%GDP (mean). Moreover, only 0.1% of firms remit 49% of tax revenue in Argentina (International Tax Dialogue, 2007).

[4] Over the period of study (1997-2011), large firms account for around 0.2% of total registered taxpayers in the corporate income tax structure; while, medium firms account for 67.6% and small firms account for 32.2%. Based on the Federal Administration of Public Revenue of Argentina (AFIP).

In this chapter, I argue that the taxation of SMEs is an important aspect of, and can help to explain, the relation between informality, tax evasion and domestic revenue mobilization in developing countries. I will address questions such as: does a cost-benefit analysis reveal it is worth taxing this sector? What should be the optimal tax structure of a country with numerous SMEs and limited tax capacity? The above-mentioned relation presents a challenge to both academic economists and policy practitioners in developing countries, hence I hope to contribute to the academic debate and inform policy.

The broad literature on optimal taxation mainly relies on the production efficiency theorem of Diamond and Mirrlees (1971), which suggests that tax systems should be aimed at maintaining full production efficiency even in second-best environments. The policy recommendation that follows from this is to avoid taxes on turnover, trade and intermediate inputs that distort production efficiency. However, although this recommendation is relevant to developed countries, the theoretical framework on which it is based ignores the numerous issues faced by developing countries, such as imperfect enforcement, limited tax capacity, informality and tax evasion. Recent studies – such as that of Kleven *et al.* (2016) – show that in environments with limited tax capacity, third-best policies are more suitable, even though they imply revenue creation at the expense of production efficiency. The objective of this study is to analyze empirically such a trade-off between revenue and production efficiency in the choice of tax instruments in a developing country, namely Argentina. In order to do this, I explore a production inefficient tax policy called the Simplified Tax Regime (SR), according to which firms are taxed either on their profits or turnover depending on which tax liability is larger[5]. This policy is based on the idea that a larger tax base is more difficult to evade. It was implemented in 1998 in Argentina with two purposes: to fight informality and to reduce evasion, or in tax policy jargon, to transform "ghosts" into taxpayers and "icebergs" into fully taxpayers[6].

I begin the analysis by presenting a simple theoretical framework based on the model of Best *et al.* (2014), which I extend by introducing turnover evasion, in order to account for the Argentinean

[5] They were first introduced in the 1970s in Latin America to deal with the difficulty to apply the VAT to small taxpayers. Later, in the 1990s (1997, in Brazil and 1998, in Argentina) were expanded to the rest of the continent, except in Venezuela, Panama and El Salvador. Nowadays, there are three types of simplified tax regimes: ones that replace the income tax, others that replace the VAT and others that replace both plus social security contributions (applied only in Argentina, Brazil and Uruguay). The criterion of qualification is mainly the turnover; although some regimes have additional objective parameters as physical area, electricity bill and number of employees. Some countries have more than one regime as Chile (5), Bolivia (3), Mexico (3), Uruguay (2) and Peru (2). The universe of taxpayers covered is: self-employed individuals, and micro and small unincorporated enterprises mainly in the commercial and service sectors. Finally, the tax calculation commonly used is a monthly fixed quota.

[6] Kanbur and Keen (2014) divide the population of taxpayers by different forms of compliance and non-compliance. Among the latter we can find "ghosts" and "icebergs". "Ghosts" are the invisible taxpayers who should be registered for tax purposes but do not, hence are outside the tax net. While, "icebergs" are registered taxpayers who illegally misreport their costs and/or output in order to reduce their tax liability.

context. The optimality conditions of this model suggest that, in countries with limited tax capacity, it may be desirable to deviate from full production efficiency in order to increase compliance. To evaluate this theoretical prediction, I use administrative data from the Federal Administration of Public Revenue (AFIP, in Spanish) covering the tax returns of all firms subject to corporate income tax between 1997 and 2011. Although it is quite rich, this dataset has two drawbacks: first, it is not micro-level data, and second, it does not represent firms in the simplified regime. To overcome these limitations, I adjust the estimation strategy of Best *et al.* (2014) while maintaining the core idea that the simplified regime gives rise to non-standard kink points, due to the joint and discontinuous change of the tax rate and the tax base at a cutoff. As the authors suggest, such kinks influence the behavior of firms in terms of compliance and real production differently, and give rise to an excess mass around the kink.

There are three main findings. First, the introduction of the policy provides SMEs with an additional incentive to reduce their turnover ('legally' or 'illegally') and to comply with costs. As a result, I observe bunching among medium firms in all periods, but more pronounced in 1997 and 1998 (respectively the year before and the year of the introduction of the policy). Second, I find that in Argentina this phenomenon is mostly the result of evasion responses. Indeed, given the speed of reaction, the observed bunching around zero and the significant bunching in 1997 and 1998 is far more likely a consequence of evasion responses rather than of real output responses, as previous studies suggest (Mosberger 2016; Lediga *et al.* 2016). Third, in line with existing research (Devereux *et al.* 2012; Dekker *et al.* 2016), bunching is asymmetric around a profit rate of 0.09. This provides strong evidence that firms respond to the taxation component of the policy. Taken together, these three findings suggest that when turnover evasion is taken into account, the revenue efficiency of the policy is not as straightforward as the theory suggests.

This study draws upon the broad literature of firms' behavioral responses to taxes (Kopczuk and Slemrod 2006), the recent bunching literature (Saez 2010; Chetty *et al.* 2011; Kleven 2016; Kleven and Waseem 2013; Kleven *et al.* 2011) and the studies of optimal taxation of firms with limited tax capacity (Emran and Stiglitz 2005; Gordon and Li 2009; Kanbur and Keen 2014; Dharmapala *et al.* 2011; Keen 2007; Keen 2012; Boadway and Sato 2009; Abramovsky *et al.* 2014). I believe the contributions of this work to the literature are threefold. First, this study provides direct empirical evidence on firms' margin responses to a widespread and questionable policy in Latin America with scarce quantitative evidence. An overview of the literature indicates that the majority of the existing work is based on developed countries; few studies analyze the relation between informal firms, evasion and taxation in developing countries[7].

Second, I contribute to the nascent literature that uses the bunching approach to estimate firm responses to tax changes. As Saez (1999) points out, the majority of studies focus on the effect of marginal tax rates in the context of personal income tax (PIT), and little attention has been paid to the corporate income tax (CIT). Third, I differ from Best *et al.* (2014) because I give a crucial role to turnover evasion and contrary to the results they obtained with Pakistan our results suggest skepticism towards the idea that a broader tax base significantly reduces evasion. Overall, three factors make this work a relevant contribution to the tax design literature: the topicality of the subject, the analytical approach used and the social implications of the policies discussed.

The rest of this chapter is structured as follows. The next section introduces the theoretical framework used for analyzing the trade-off between revenue and production efficiency. In section 4.3, I discuss the relevant institutional background and data. Section 4.4 explains the empirical strategy used in estimating firms' behavioral responses. In section 4.5, I present our results. Section 4.6 deals with some experiences of the impact of the policy. Finally, section 4.7 briefly concludes.

4.2 Theoretical framework

The purpose of this section is to develop a conceptual framework within which will be examined the trade-off between production and revenue efficiency in the presence of tax evasion. I begin with a brief review of Best *et al.* (2014) who model this trade-off for Pakistan, I then take this model as our baseline model and propose two extensions to make it compatible with the Argentinean setting.

4.2.1 The trade-off in the Best *et al.* (2014) framework

Best *et al.* (2014) use a static model of optimal taxation of firms with no uncertainty. In a partial equilibrium framework with no inputs and only one final good, firms choose how much output y to produce and the costs to report to the tax administration $\hat{c}$. I assume firms can *only* over-report their costs $\hat{c} > c(y)$ in order to reduce their reported profits (and therefore tax liability). The tax liability depends on firms' output and reported costs: $T(y, \hat{c}) = \tau[y - \mu\hat{c}]$, where μ is the tax base

[7] Indeed, Kleven and Waseem (2013) were the first to extend the literature to a developing country using administrative data.

parameter which determines the tax regime the firm belongs to, either to the simplified tax regime with a turnover tax base ($\mu = 0$) or to the general regime with a pure profit tax base ($\mu = 1$). Misreporting entails costs $g(\hat{c} - c(y))$, which correspond for instance to the risk of being audited, the fine paid when the firm is caught by the tax administration, the productivity losses from operating in cash, the costs of not keeping accurate accounting books or the costs from changing the production process to eliminate verifiable evidence (Kopzuk and Slemrod 2006; Best *et al.* 2014). These costs are convex with the level of tax evasion[8]. Also, profits depend positively on after-tax income and negatively on reported costs. Moreover, I assume a small open economy where firms are price-takers; hence I normalize the price of the final good so that turnover and output are identical[9]. As a result, I have the true after-tax profit: $\pi(y, \hat{c}) = y - c(y) - \tau[y - \mu\hat{c}] - g(\hat{c} - c(y))$ and the reported after-tax profit: $\hat{\pi}(y, \hat{c}) = y - \hat{c} - \tau[y - \mu\hat{c}]$. The optimization problem of a representative firm is therefore:

$$\max_{y,\hat{c}} \pi(y, \hat{c}) = y - c(y) - \tau[y - \mu\hat{c}] - g(\hat{c} - c(y))$$

$$FOCs:$$

$$\frac{d\pi}{dy} = 0 \rightarrow \quad c'(y) = 1 - t\left(\frac{1-\mu}{1-t\mu}\right) = 1 - t_E \tag{1}$$

$$\frac{d\pi}{d\hat{c}} = 0 \;\rightarrow \quad g'(\hat{c} - c(y)) = t\mu \tag{2}$$

Where, $t\left(\frac{1-\mu}{1-t\mu}\right)$is the effective marginal tax rate (t_E).

The first of these expressions determines the real output level. Note that the effective tax rate reduces the marginal return to real output. It is a distortionary tax which creates a wedge and which depends on the statutory tax rate and the tax base; $\frac{dt_E}{dt} \geq 0, \frac{dt_E}{d\mu} \leq 0$. An increase of the tax rate ($\Delta\tau > 0$) or a larger tax base ($\Delta\mu < 0$) raises the effective tax rate, which in turn reduces the marginal return of real output and, hence decreases firms' real output level. The second expression determines the level of evasion and it is increasing in statutory tax rate and in tax base. Indeed, an increase of the tax rate ($\Delta\tau > 0$) or a narrower tax base ($\Delta\mu > 0$) raises the marginal return of

[8] As a result, I have three possible cases: no misreporting ($\hat{c} - c(y) = 0$), over-reporting ($\hat{c} - c(y) > 0$) and under-reporting ($\hat{c} - c(y) < 0$). Is not unreasonable to think that firms under-report costs; in fact, Carrillo *et al.* (2014) show that when the audit probability is a decreasing function of the profit rate, firms under-report revenues and costs in order to 'look small' and, hence avoid being audited. Note that in our case, the SR affects firms' size because it gives incentives to firms to stay small indefinitely and/or to reduce their size in order to benefit from the regime. However, firms modify their size through misreporting as long as the tax payment is larger or equal to the costs of misreporting. If the costs of misreporting are too large, then firms will prefer to not misreport and will reveal their true costs and/or turnover.

[9] Therefore, net income can be referred to as profits and gross income as turnover or output. The profit tax is thus over net income while the turnover tax is over gross income.

misreporting ($\Delta t\mu > 0$) which in turn give more incentives to firms to evade by over-reporting costs[10].

When firms are subject to the general regime, they are taxed on their profits ($\mu = 1$) and the statutory tax rate is the profit tax. Equations (1) and (2) become: $c'(y) = 1$, $g'\big(\hat{c} - c(y)\big) = \tau_\pi$. Observe in the first expression that the wedge disappears, so that the firm's production decision is undistorted. The second expression implies that firms have an incentive to evade in the general regime because the marginal return of misreporting is the profit tax. Conversely, when firms are subject to the simplified tax regime, they are taxed on their turnover ($\mu = 0$) and the statutory tax rate is the turnover tax, hence equations (1) and (2) become: $c'(y) = 1 - t_y$, $g'\big(\hat{c} - c(y)\big) = 0$. In this case, a wedge distorts the production decision of firms by reducing the marginal return to real output; on the other hand, firms get no benefits from misreporting costs.

The model specifies a government which can only raise revenue by taxing firms. This is not an unreasonable assumption in developing countries where, due to high administrative costs, income taxes are often concentrated on CIT[11]. In this setting, the government has two instruments for tax policy, the tax rate and the tax base. As a result, the government sets the tax base μ and the tax rate τ in the presence of tax evasion in order to maximize welfare $W = \pi(y, \hat{c})$ under the constraint of collecting a revenue $R \leq T(y, \hat{c})$, where, $T(y, \hat{c}) = \tau[y - \mu\hat{c}]$. Both FOCs give $\lambda \geq 1$, where λ denotes the (endogenous) marginal costs of public funds (intuitively, it is the 'price' the government faces to collect revenue in order to finance public expenditure).

This simple model does not include the behavior of households. It is assumed that the only individuals in the economy are the firms' owners, whose consumption depends on the after-tax profits obtained. Maximizing welfare is thus equivalent to maximizing the aggregate consumption or after-tax profit, subject to an exogenous revenue requirement R. From this model Best *et al.* (2014) state the following optimal tax rules:

- Lemma 1: When there is perfect enforcement, then the optimal tax base is $\mu = 1$.

[10] For example, if the government improves its tax capacity by increasing the number of inspections or the amount of fines, then it becomes costlier for a firm to evade. In the 2004 reform, the Argentinean tax administration introduced a fine (100 - 3 000 pesos) plus the precautionary closing of the business in case of tax evasion. Five years later, in the 2009 reform, the fine was modified to 50% of the single tax. In the model, these policy changes would translate into higher costs of evasion.

[11] The empirical evidence suggests that low fiscal capacity countries rely heavily on taxation of firms. For example, in Argentina CIT revenue represents 65% of the tax income revenue, while PIT represents only 31% (mean over 1990-2010; based on the ICTD Government Revenue Dataset (ICTD GRD, 2014)).

Proof: Perfect enforcement implies no evasion, so firms report their true costs $\hat{c} = c(y)$ and $g(0) = 0$. The optimization problem of firms becomes: $\max_{y} \pi(y) = y - c(y) - \tau[y - \mu c(y)]$ where the result is an efficient output decision: $c'(y) = 1$. Consequently, with perfect tax enforcement the theorem of Diamond and Mirrless (1971) holds, full production efficiency is maintained with $\mu = 1$ and a pure profit tax.

- Proposition 1: When there is imperfect enforcement, then the optimal tax base is $\mu = 0$.

Proof: With imperfect tax enforcement, firms have an incentive to misreport $\hat{c} > c(y)$ even though it entails some cost $g(\hat{c} - c(y)) > 0$. In such context, the firms' optimization problem is: $\max_{y,\hat{c}} \pi(y, \hat{c}) = y - c(y) - \tau[y - \mu\hat{c}] - g(\hat{c} - c(y))$. This results in an inefficient output decision $c'(y) = 1 - t_y$; consequently, firms deviate from optimality.

Proposition 1 is a generalization of the optimal tax rule (Lemma 1) in the presence of tax evasion, it captures the trade-off between production and revenue efficiency in the choice of the tax base and reflects the notion that "a broader base is harder to evade" (Best *et al.* 2014, p.2). From a policy perspective, if the revenue efficiency concern is stronger than the production efficiency concern, then it is socially optimal to switch to turnover tax (i.e. broadening the tax base) $\mu = 0$. As a result, the production wedge increases, producing a second-order welfare loss, while the evasion rate decreases, leading to a first-order welfare gain. Conversely, if the production efficiency concern is stronger than the revenue efficiency concern it will be socially optimal to choose a profit tax, by setting $\mu = 1$. In this case, firms' real output decision is undistorted, but this is at the expense of evasion. The first case appropriately describes the case of developing countries with imperfect tax enforcement and weak tax capacity, while the latter approximates the reality of a developed country.

4.2.2 Extension

(a) Turnover evasion

In the baseline model it was assumed that firms could only over-report costs[12]. In this section I extend the model to allow for turnover evasion. The extension is justified by the idea that Argentinean firms have strong incentives to under-report turnover because is the main criterion of qualification and categorization in the simplified tax regime. Firms can over-report costs $\hat{c} > c(y)$ and under-report output $\hat{y} < y$, and both of these entail costs $g(\hat{c} - c(y), y - \hat{y})$. In this setting,

[12] The original assumption based on Best *et al.*'s (2014, p.4) idea that "it may be easier to fabricate costs than to conceal revenues".

firms choose how much output y to produce, as well as the output $\hat{y}$ and costs $\hat{c}$ reported to the tax administration. The optimization problem of the representative firm can thus be written:

$$\max_{\hat{y},\hat{c},y} \pi(y,\hat{y},\hat{c}) = y - c(y) - \tau[\hat{y} - \mu\hat{c}] - g(\hat{c} - c(y), y - \hat{y})$$

$$FOCs:$$

$$\frac{d\pi}{dy} = 0 \rightarrow \quad c'(y) = 1 - t\left(\frac{1-\mu}{1-t\mu}\right) = 1 - t_E \tag{3}$$

$$\frac{d\pi}{d\hat{y}} = 0 \rightarrow g'_{\hat{y}} = \tau \tag{4}$$

$$\frac{d\pi}{d\hat{c}} = 0 \rightarrow g'_{\hat{c}} = \tau\mu \tag{5}$$

Equation (3) is the same as the baseline model. Similarly, Equation (4) determines the level of turnover evasion while equation (5) dictates the level of costs evasion. Both are increasing in statutory tax rate, but only equation (5) is affected positively by the tax base. Moreover, firms in the general regime ($\mu = 1$) have the same incentives to evade in turnover and in costs because the marginal return of misreporting is the profit rate: $g'_{\hat{y}} = g'_{\hat{c}} = \tau_\pi$. This result is reasonable in the general regime, where evasion in costs and/or in turnover reduces reported profits and hence tax liability. On the other hand, firms in the simplified regime ($\mu = 0$) only have an incentive to under-report turnover: $g'_{\hat{y}} = \tau_y$, $g'_{\hat{c}} = 0$.

In this extended model, the government's optimization problem (and hence the result derived from it) remains the same: $\lambda \geq 1$.

To conclude, the introduction of turnover evasion to the baseline model does not contradict our previous results; on the contrary, it is helpful in furthering our understanding of the problem. Indeed, with this simple extension I captured the idea that firms under-report turnover irrespective of the tax regime to which they are subject, while they have more incentives to evade in the general regime than in the simplified regime because $0 < \tau_y < \tau_\pi$ (see Table 4.1).

(b) Single tax

In this second extension I assume a fixed fee rather than a turnover tax. This is to reflect the fact that in the simplified regime Argentinean firms pay a fixed fee called single tax, which is determined by the tax administration and depends on the category to which the firm belongs. The single tax thus depends positively on the reported turnover $\theta(y)$. The optimization problem for a representative firm with cost evasion *only* is:

$$\max_{y,\hat{c}} \pi(y,\hat{c}) = y - c(y) - \mu_1\theta(y) - \mu_2\tau[y-\hat{c}] - g\big(\hat{c} - c(y)\big)$$

$$FOCs:$$

$$\frac{d\pi}{dy} = 0 \rightarrow \quad c'(y) = \frac{1-\mu_1\theta'_y - \mu_2\tau}{1-\mu_2\tau} \tag{6}$$

$$\frac{d\pi}{d\hat{c}} = 0 \ \rightarrow \quad g'_{\hat{c}} = \mu_2\tau \tag{7}$$

Turnover evasion is now introduced to see if there are any significant changes in the results. Note that in this case the single tax $\theta(\hat{y})$ is decreasing in the turnover evasion; $\frac{d\theta(\hat{y})}{d\hat{y}} \leq 0$. The optimization problem for a representative firm with turnover and cost evasion is:

$$\max_{\hat{y},\hat{c},y} \pi(y,\hat{y},\hat{c}) = y - c(y) - \mu_1\theta(\hat{y}) - \mu_2\tau[\hat{y}-\hat{c}] - g(\hat{c} - c(y), y - \hat{y})$$

$$FOCs:$$

$$\frac{d\pi}{dy} = 0 \rightarrow \quad c'(y) = \frac{1-\mu_1\theta'_y - \mu_2\tau}{1-\mu_2\tau} \tag{8}$$

$$\frac{d\pi}{d\hat{y}} = 0 \rightarrow g'_{\hat{y}} = \mu_1\theta'_{\hat{y}} + \mu_2\tau \tag{9}$$

$$\frac{d\pi}{d\hat{c}} = 0 \rightarrow g'_{\hat{c}} = \mu_2\tau \tag{10}$$

When there is only cost evasion (equation 6 and 7), firms in the general regime ($\mu_1 = 0, \mu_2 = 1$) maintain full production efficiency and over-report costs: $c'(y) = 1$, $g'_{\hat{c}} = \tau_\pi$, while firms in the simplified regime ($\mu_1 = 1, \mu_2 = 0$) deviate from production efficiency and report costs truthfully: $c'(y) = 1 - \theta'_y$, $g'_{\hat{c}} = 0$. When there is turnover and costs evasion (equations 8-10), firms in the general regime ($\mu_1 = 0, \mu_2 = 1$) evade in turnover and costs: $g'_{\hat{y}} = g'_{\hat{c}} = \tau_\pi$, while firms in the simplified regime ($\mu_1 = 1, \mu_2 = 0$) only under-report turnover: $g'_{\hat{c}} = 0, g'_{\hat{y}} = \theta'_{\hat{y}}$. In both cases, the government chooses the tax rate τ and the tax base μ_1, μ_2 to maximize welfare subject to the revenue requirement: $R \leq \mu_1\theta(y) + \mu_2 T(y,\hat{c})$ when there is only costs evasion or $R \leq \mu_1\theta(\hat{y}) + \mu_2 T(\hat{y},\hat{c})$ when there is turnover and costs evasion. The result from the government's optimization problem in both cases remains the same: $\lambda \geq 1$. Therefore, this extension leads to the same predictions of the baseline model. Consequently, whether a single tax or a turnover tax is used should not alter the main insights of the model.

This theoretical framework gives qualitative predictions on the optimal taxation of firms under the presence of tax evasion. In the empirical section, the quantitative implications of such predictions will be examined by exploiting a production inefficient tax policy in Argentina, namely the simplified tax regime.

4.3 Institutional setting and data

4.3.1 Corporate income tax in Argentina

Corporate taxation is a crucial source of revenue in Argentina, as it raises 4.4% of GDP, which represents about 29% of all central tax revenues[13]. The tax system is residence-based and the current CIT rate is 35%. In the period under study there was an average of 132 298 firms in the General Regime (GR) filing tax returns each year and 1 561 711 active firms registered in the Simplified Regime (SR) each year (Table A.1). Despite these numbers, the revenue collected in the SR is insignificant in Argentina's tax system: it accounts for only 3% of CIT revenue and 1% of total tax revenue (mean over 1999 to 2011, see Table A.1)[14].

The introduction of the SR in November 1998 had two purposes: to fight informality (first motivation) and to reduce tax evasion (second motivation). This scheme is one of the few in Latin America that links informality, taxation and social protection[15]. It consists of a single tax composed by two components: a monthly tax which replaces income tax (PIT and CIT) and VAT, and a social security component that includes retirement benefits and health coverage. To keep the model simple, I ignore the social security contributions and focus only on the monthly tax and the CIT[16]. The SR classifies firms in eight categories depending on their reported turnover and each category has a different monthly tax. Importantly, in order to follow the methodology of Best *et al.* (2014), I transform the single tax to a turnover tax, so that the turnover tax obtained is the minimum amount that a firm allocated in the lowest category can pay[17]. However, when comparing categories, the turnover tax of the lowest category is in fact the highest turnover tax in proportional terms, suggesting certain regressivity in the SR (as mentioned in the reports of the tax administration).

The idea of the SR is to give incentives to small taxpayers to voluntarily comply with their tax obligations by offering access to a retirement plan and to health insurance, and by minimizing the costs of compliance. These small taxpayers are self-employed individuals, unincorporated small businesses such as cooperatives, and irregular societies of up to three members. The main rules of

[13] Mean over 1997-2011, based on the ICTD Government Revenue Dataset (ICTD GRD, 2014).

[14] Nevertheless, the SR of Argentina collects the second highest revenue among SRs in Latin America (after Brazil's simplified tax regime, SIMPLES) (ILO, 2014).

[15] Since 2004, the SR contains complementary special regimes for specific 'hard-to-tax' sectors, namely: (i) the Regime of Social Inclusion and Promotion of Independent Work, (ii) the Simplified Regime for Effectors of Local Development and Social Economy, (iii) the Special Regime for Workers Associated to Labor Cooperatives and (iv) the Simplified Regime for Domestic Service Workers.

[16] So, I use the terms "single tax" and "monthly tax" interchangeably throughout the paper.

[17] The turnover tax is the single tax (annual) divided by the lowest and highest annual turnover base of each category; thus, I have a minimum and a maximum turnover tax in each category. To follow as close as possible the methodology of Best *et al.* (2014), I choose the minimum turnover tax from the lowest category.

the SR are as follows. Once a taxpayer has adhered to the SR, a minimum period of permanence (one calendar year) is required. Also, when the firm wishes to withdraw from the SR, it has to fulfill the tax and social security obligations imposed by the GR at the latest on the first day of the month following the withdrawal. To be eligible, the highest turnover obtained from the principal activity in the previous year should not exceed the limit established by the tax administration. Other requirements for eligibility are that the firm has to meet some objective parameters, it cannot be an importer, it cannot reclaim credits on inputs. In addition, the firm must report its turnover and objective parameters regularly in order to confirm they meet the requirements[18]. On the other hand, a firm in the SR is not required to fill any tax return because it is excluded from VAT and CIT, nor is it required to keep accounting books.

During the period under study, there were three reforms affecting either or both of the two regimes. The first reform (December 1998) increased the profit tax rate from 33% to 35%, the second reform (July 2004) raised the single tax of the highest categories in the SR and the third reform (December 2009) decreased the single tax of the lowest category. The three reforms introduced additional modifications that are deliberately ignored in order to focus on the changes of the tax rate. Table A.1 (Panel A) shows the variations in profit tax rate and turnover tax rate over the period under study. Similarly to Best *et al.* (2014), I exploit these variations in the empirical analysis. For practical reasons, I divide the period under study based on the policy and the three reforms identified.

Table 4.1: Tax rates and tax kinks

	1997	1998	1999/2003	2004/2009	2010/2011
Panel A: Tax rates					
Turnover tax (min.)	-	0.033	0.033	0.033	0.020
Turnover tax (total, min.)	-	0.066	0.066	0.088	0.110
Profit tax	0.33	0.33	0.35	0.35	0.35
Panel B: Tax kinks					
Profit rate (min.)	-	0.10	0.09	0.09	0.05
Profit rate (total, min.)	-	0.20	0.18	0.25	0.31

Notes: Turnover tax (min.) refers to the monthly tax and turnover tax (total,min.) refers to the monthly tax plus social security contributions. Profit rate is defined as profits as a fraction of turnover.

4.3.2 Data

[18] Originally, this was every tax year, but since 2004, firms must report every four months (May, September and January).

The analysis is based on administrative data from the Federal Administration of Public Revenue (AFIP, in Spanish) for the period 1997-2011[19]. It is an annual cross-section sample with sampling weights to reflect the distribution of CIT returns of all the population[20]. The data has two limitations that are important to highlight. First, it contains *only* firms filing the CIT returns, i.e. only firms in the GR. The next section explains how this limitation is dealt with. Second, the original data is already binned, firms are already grouped in 17 thresholds based on their turnover, ranged from 0 to more than 500 000 000 pesos (Table A.2). Consequently, the fact that the data is not completely disaggregated introduces measurement errors in the bunching estimates and the empirical density distribution is not completely smooth.

4.3.3 Sample selection

Before the introduction of the policy, the GR was the only regime in the CIT structure, and firms outside of it were informal firms, called "ghosts" in the tax jargon. Thus, firms could only move from the GR to informality and vice versa. Importantly, within the GR there were firms misreporting costs and turnover, colloquially called "icebergs" in the GR. Since the introduction of the policy, there were two regimes co-existing in the CIT structure, the GR and the SR. Six flows are identifiable: from the GR to the SR and vice versa; from the GR to informality and vice versa, and from the SR to informality and vice versa. Of course, in the SR, there are also firms that under-report turnover, called "icebergs" in the SR. I restrict the analysis to the flow from the GR to the SR because, as explained above, the data relates exclusively the behavior of firms in the GR. Flows between formality and informality, although they provide interesting insights given the first motivation of the policy, are not the focus of this study. Instead, I focus on the second motivation of the policy, namely the reduction of evasion.

For tractability, I selected three variables: turnover, profit and taxable income. The information available on the CIT returns includes all kind of balance sheet items such as total costs, total purchases, tax liabilities, total assets, initial and final stocks, etc., but the three aforementioned variables are sufficient for our purposes. Figures B.1 and B.2 identify the variables used in the empirical analysis. In this regard, the calculation of the profit rate (defined as profits as a fraction of turnover) is worth explaining. Indeed, when either the calculated profit (reported turnover minus

[19] In Argentina, the tax year coincides with the calendar year, i.e. it runs from January 1 to December 31. However, the last day for firms to present their CIT returns to the tax administration is the June 30. Note that I do not consider the tax year 2001 because the observations were not sufficient. Indeed, in 2001, the tax administration modified the format of the tax returns. Another reason for excluding the tax year 2001 is that the Argentinean economy suffered of a deep recession ("corralito") in that year.

[20] Note that electronic filing (Presentación de DDJJ y Pagos) is optional for all firms; but around 97% of firms used this method from 2006 to 2010 (CIAT, http://www.ciat.org/index.php/es/productos-y-servicios/ciatdata/anexos-estadisticos.html) which ensures less measurement error in the data, as highlighted by Best *et al.* (2014).

reported costs) or the reported profit are used, the distribution of the profit rate is above zero and too on the right of the cutoff even when social security contributions are included. For this reason, the *reported taxable income*[21] is used in the empirical analysis.

In the original data, firms are classified in 17 categories defined by thresholds relating to their reported turnover (see Table A.2), even though all firms are taxed on their profits by a flat tax rate. I take advantage of this format and divide the data in groups according to their eligibility and size[22]: all firms (thresholds$[1-17]$), eligible or small firms (thresholds$[1-2]$), non-eligible firms (thresholds$[3-17]$), medium firms (thresholds$[3-15]$) and large firms (thresholds$[16-17]$).

4.4 Empirical methodology

The empirical methodology used here builds on Best *et al.* (2014), but is adapted to account for the two limitations of the data. Therefore, I first briefly present the strategy and intuition underlying the approach of Best *et al.* (2014). Then, I explain how Chapter 4 differs from them in the construction of the empirical methodology, and I describe the intuition that underlies our approach.

4.4.1 Bunching evidence

As stated in the previous section, there was only one regime in the CIT structure before the introduction of the SR (namely the GR), while there were two regimes coexisting (the SR and the GR) after the policy was implemented. This is depicted in Fig. 4.1, which clearly shows that firms with a tax liability above certain cutoff belong to the GR while firms with a lower tax liability belong to the SR.

Firms are thus taxed either on their profits or their turnover, depending on which tax liability is larger. Following Best *et al.* (2014), this main idea is described by the following equation:

$$T(y,\hat{c}) = max\left[t_{\pi}(y-\hat{c}), t_y y\right] \tag{11}$$

[21] Note that firms report their taxable income as the profit increased or decreased by items modifying the tax base, so that the profit tax rate is levied on it.

[22] Based on the "Boletín Oficial de la República de Argentina, No. 24/2001".

Considering a firm at the border between both regimes, both tax liabilities can be equalized[23]:

$$t_\pi(y - \hat{c}) = t_y y \tag{12}$$

$$\leftrightarrow \hat{\pi} \equiv \frac{(y-\hat{c})}{y} = \frac{t_y}{t_\pi} \tag{13}$$

This gives the cutoff separating the two regimes, defined by the ratio between both tax rates being equal to a profit rate (reported taxable income as a share of reported turnover). Based on this simple empirical strategy, Best *et al.* (2014, p.11) argue that the introduction of the SR gives rise to non-standard kink points because of the joint change in the tax rate and the tax base. Under this framework, the introduction of the SR affects firms' decisions on real output and compliance differently, the policy causes an outflow of some firms from the GR to the SR. Once in the new regime, firms decide to produce less and to comply in costs. Both of these changes (under the assumption of diminishing returns to scale) increase their profit rate and thus create bunching at the cutoff. According to Best *et al.* (2014), bunching represents real output ($\Delta y < 0$) and evasion responses ($\Delta \hat{c} < 0$), but mostly evasion responses from firms below the cutoff. In fact, the authors go further and argue that the bunching observed is the result of better compliance[24].

Unfortunately, the two behavioral responses used by Best *et al.* (2014) to explain bunching cannot be observed, because there is no information about firms in the SR (cf. second limitation of the data). Hence, taking inspiration from Best *et al.* (2014), I follow a backward process and attempt to construct my own strategy and intuition based on what is observed in the data. Contrary to what would be expected if one followed the reasoning of Best *et al.* (2014), the data shows bunching around the cutoff among firms in the GR. I argue that in Argentina firms in the GR could be indirectly affected by the policy, something that Best *et al.* (2014) completely discard.

This hypothesis rests on three main intuitions, which will be verified in the next section. First, like Best *et al.* (2014), I argue that some firms move from the GR to the SR, and that these firms then decide to produce less and comply in costs. According to Best *et al.* (2014), firms reduce turnover because in the SR they have no incentives to continue producing at the optimal level

[23] Based on previous studies (Saez 2010; Kleven and Waseem 2013; Best *et al.* 2014), a smooth distribution and homogeneous responsiveness across firms is assumed. In other words, it is assumed that "there exists a single marginal buncher who reveals the bunching response" (Best *et al.* 2014, p.12). In turn, this allows one to equalize the tax liabilities.

[24] Best *et al.* (2014) arrive to this conclusion by restricting real output responses. First, since the analysis is based on a partial equilibrium model it avoids an additional source of production inefficiency, namely the cascading effect. Second, the authors assume that bunching at the kink only captures intensive margin responses, restricting production distortions from the extensive margin (i.e. from informal firms). Third, the authors assume a non-distortionary profit tax and a distortionary turnover tax; but since the latter is smaller than the former, the distortion generated by the turnover tax is minimal at the cutoff.

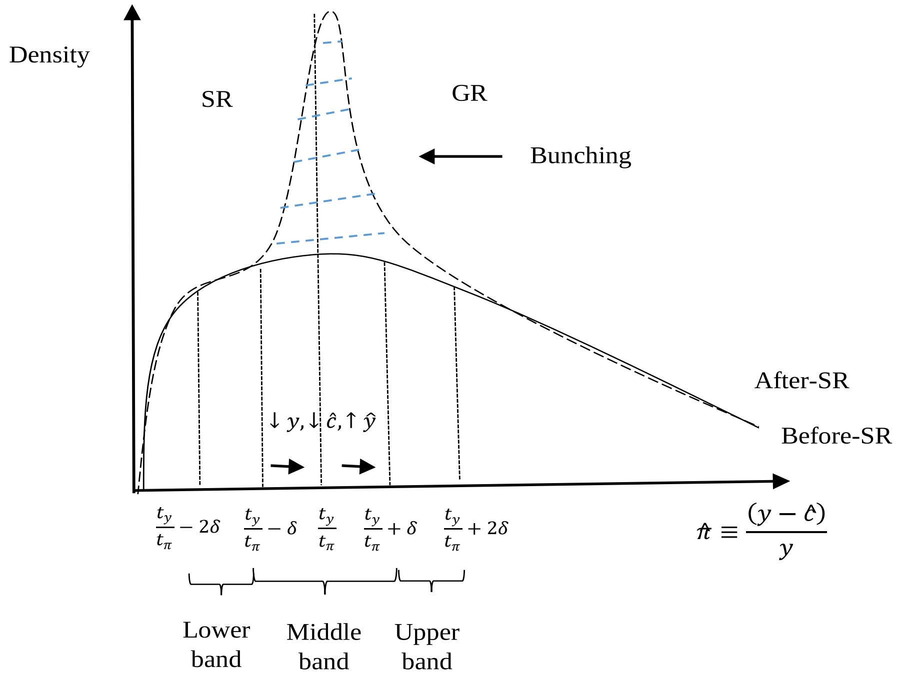
(since the marginal return to output is lower than in the GR: $c'(y) = 1 - t_y$). The argument is simpler: firms in the SR reduce turnover in order to be classified in the lowest categories of the regime and pay a lower single tax. This also implies that firms have an incentive to continue misreporting turnover in the SR: $g'_{\hat{y}} = \tau_y$. Therefore, the responses below the cutoff (see Fig. 4.1) represent real output ($\Delta y < 0$) and evasion ($\Delta \hat{c} < 0, \Delta \hat{y} > 0$) responses. Importantly, this introduces an additional evasion response, namely turnover evasion. Unfortunately, this behavior is unobservable due to the second limitation of the data. However, the reports of the tax administration (AFIP, 2006) confirm the existence of "icebergs" in the SR, as they show the agglomeration of firms among the lowest categories of the SR and the frequent re-categorizations towards the highest categories of the SR. Also, the reports of the ILO (2013, 2014) conclude that the SR has become a 'shelter' for evaders. Section 4.6 will examine this issue more closely.

The second intuition is that the bunching observed above the cutoff is the response of small and medium firms from the GR. With the introduction of the policy, these firms have an additional incentive to reduce turnover 'legally' or 'illegally'. In the case of medium firms, the aim would be to become eligible and move to the SR, and in the case of small firms, to be classified in the lowest categories of the SR[25]. Also, those firms have an incentive to stop over-reporting costs to be consistent with the information revealed to the tax administration. These two behavioral changes among SMEs move the distribution of the profit rate to the right, creating an excess mass around the cutoff. By contrast, large firms are not expected to respond to the policy change because it would be too costly for them to reduce turnover to the level required by the SR, but also because large firms are more likely to have international activities and could perceive being registered in the VAT as a commercial advantage. Therefore, the responses above the cutoff (see Fig. 4.1) represent real output ($\Delta y < 0$) and evasion responses ($\Delta \hat{c} < 0, \Delta \hat{y} > 0$) from SMEs.

Finally, the last intuition is that the observed bunching represents mostly evasion responses ($\Delta \hat{c} < 0, \Delta \hat{y} > 0$). When turnover evasion is introduced in the model, firms have an incentive to misreport turnover ($\Delta \hat{y} > 0$) in both regimes, and this effect might offset the reduction in cost evasion ($\Delta \hat{c} < 0$), in turn decreasing compliance.

[25] Note that the behavioral decisions of medium and small firms are observable because to apply to the SR, firms need to prove they meet the turnover criteria for at least 12 months. Therefore, when firms take their production and compliance decisions for those 12 months, they are still in the GR.

Figure 4.1: Bunching theory



Source: Based on Best *et al.* (2014, p.30) and Saez (2010, p.187)

4.4.2 Bunching estimation

Now, I turn to the methodology used in the bunching estimation. The estimation strategy builds on Saez (2010), as well as on the bunching empirical literature (Best *et al.* 2014; Lediga *et al.* 2016, Mosberger 2016, Dekker *et al.* 2016, Devereux *et al.* 2012).

In the seminal study of Saez (2010) the author estimates the amount of bunching B as follows:

$$B = \int_{\pi^*}^{\pi^*+\Delta\pi^*} h_0(\pi).\partial\pi \simeq h_0(\xi)\Delta\pi^* \qquad (14)$$

The excess mass is estimated by comparing the empirical income distribution (with an excess mass around the kink) with respect to a counterfactual distribution (what the distribution would have looked like had the kink absent). Saez (2010) constructs the counterfactual distribution using the empirical (observed) income distribution around the kink. For doing so, "the bunching window is chosen as the area around the kink that is visibly affected by the bunching" (Best *et al.* .2014, p.20). The bunching window is defined by a middle band around the kink $[\tau_y/\tau_\pi - \delta, \tau_y/\tau_\pi + \delta]$ and two surroundings bands $[\tau_y/\tau_\pi - 2\delta, \tau_y/\tau_\pi - \delta]$ and $[\tau_y/\tau_\pi + \delta, \tau_y/\tau_\pi + 2\delta]$, below and above the kink, as depicted in Fig. 4.1. As in Saez (2010, p.187), the parameter δ measures the width of those bands and its choice matters when estimating excess bunching: “if δ is too small, the amount of excess bunching will be underestimated; but if δ is too large it will be overestimated”. As the author suggests, I select δ graphically to ensure that the full excess mass is included in the band $\left[\tau_y/\tau_\pi - \delta, \tau_y/\tau_\pi + \delta\right]$, for this reason the middle band is always selected in such a way that the kink points are at the center. Then, Saez (2010) estimates the excess mass by comparing the number of firms in the band around the kink with respect to the number of firms in the two surrounding bands as follows:

$$B = \int_{\pi^*-\delta}^{\pi^*+\delta} h(\pi)\partial\pi - \int_{\pi^*-2\delta}^{\pi^*-\delta} h(\pi)\partial\pi - \int_{\pi^*+\delta}^{\pi^*+2\delta} h(\pi)\partial\pi \tag{15}$$

Where, $\pi \equiv \frac{(y-\mathcal{C})}{y} = \tau_y/\tau_\pi$.

Furthermore, to get the number of firms in each band denoted as $\widehat{H}^*, \widehat{H}^*_+, \widehat{H}^*_-$ the author regresses simultaneously a dummy variable for belonging to each band on a constant in the sample of firms belonging to any of those three bands. Then, he estimates $\hat{h}(\pi^*)_- = \frac{\widehat{H}^*_-}{\delta}$, $\hat{h}(\pi^*)_+ = \frac{\widehat{H}^*_+}{\delta}$ and finally, he computes the empirical bunching parameter $\widehat{B} = \widehat{H}^* - \widehat{H}^*_+ - \widehat{H}^*_-$. Standard errors are then calculated using the delta method (alternatively the bootstrap method).

4.5 Results

Bunching estimation is a genuinely visual technique (Bastani and Selin 2014). Accordingly, along this section I display graphs and bunching estimates. First, I show evidence of bunching for all the period according to firms’ size and eligibility. Then, I exploit the variations in the tax kink by comparing the reforms applied in December 1998 ($\Delta\tau_\pi > 0$), July 2004 ($\Delta\tau_y > 0$) and December 2009 ($\Delta\tau_y < 0$) to test whether the excess mass at the tax kink is indeed a response to the tax system.

4.5.1 Bunching evidence

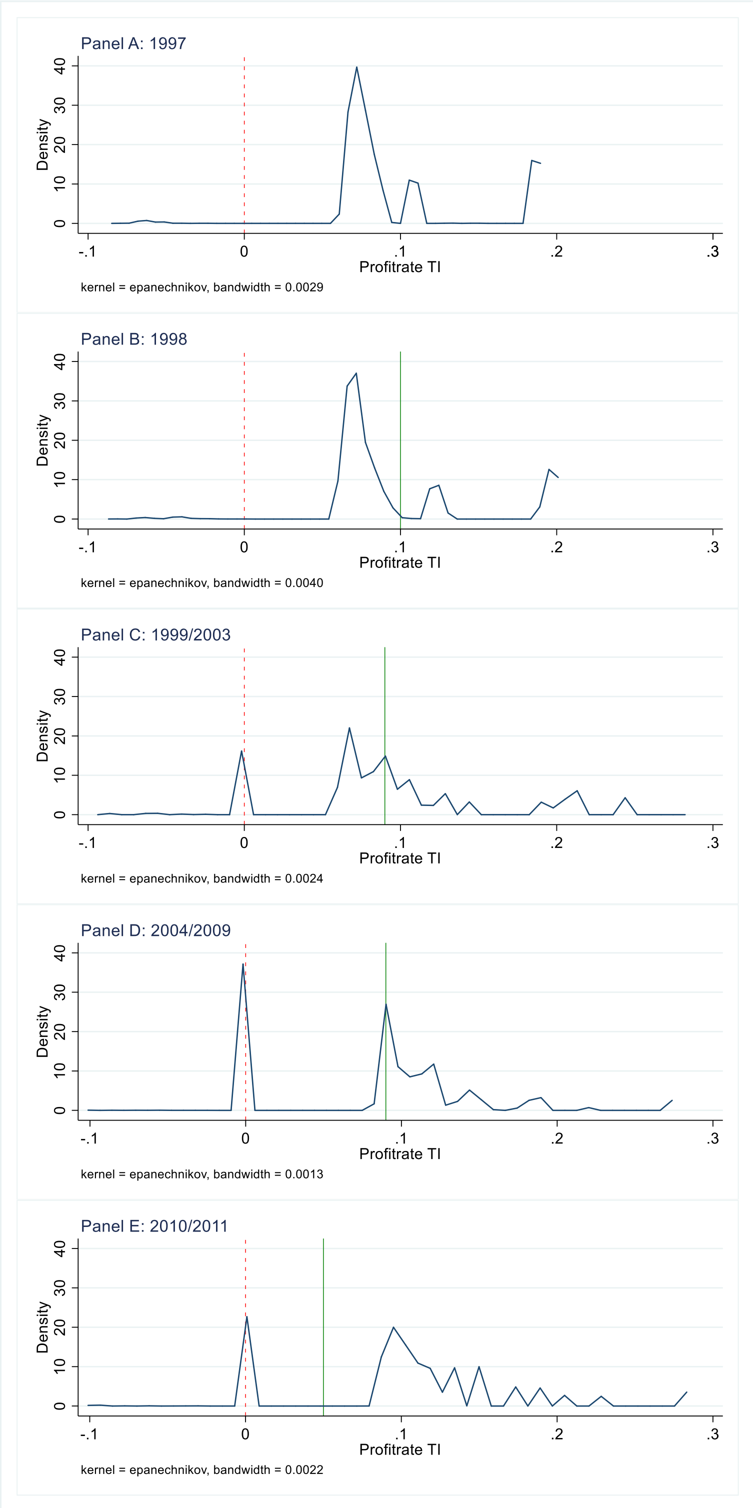
The aim of this subsection is to show evidence that firms in the GR do indeed bunch and that this bunching is around tax kinks. Figure 4.2 displays bunching evidence for different years (1997, 1998, 1999/2003, 2004/2009 and 2010/2011) and for all firms. Empirically, bunching estimates are significant in all the period except in 1999/2003 and 2010/2011 (see Table 4.2, column (1)). This is so, because the excess mass is placed to the left of the kink point in 1999/2003 and to the right in 2010/2011.

To identify who are the main firms responsible of the overall bunching (i.e. bunchers), I divide the sample into two, according to whether a firm is eligible or not. The density distributions are plotted in Figures 4.3 and C.1. At first glance, there is bunching in all years only for non-eligible firms. But, if I disaggregate this group into medium and large firms, bunching occurs in all years for medium firms (Fig. 4.4) while there is no bunching for large firms (Fig. C.2). This is precisely what is observed in Table 4.2 (Column (2) and (3)). This finding seems to confirm the second intuition, i.e. that medium firms are indirectly affected by the policy[26]. Medium firms have more incentives to decrease their turnover 'legally' or 'illegally', to reduce their tax liability and/or to become eligible and move to the SR. As explained in the previous section, such behavior increases the reported profit rate and moves the distribution to the right, with a clustering of medium firms around the kink point. On the other hand, I do not detect any clear bunching among small or eligible firms. Contrarily to the intuition, small firms are not affected by the introduction of the SR probably because small firms already meet all the requirements needed to be an eligible firm and move to the SR.

Finally, in respect to the sensitivity analysis in Table 4.2, it is important to mention that the bunching estimates are fairly sensitive with respect to the choice of the bandwidth, which confirms that firms bunch diffusely around the kink point.

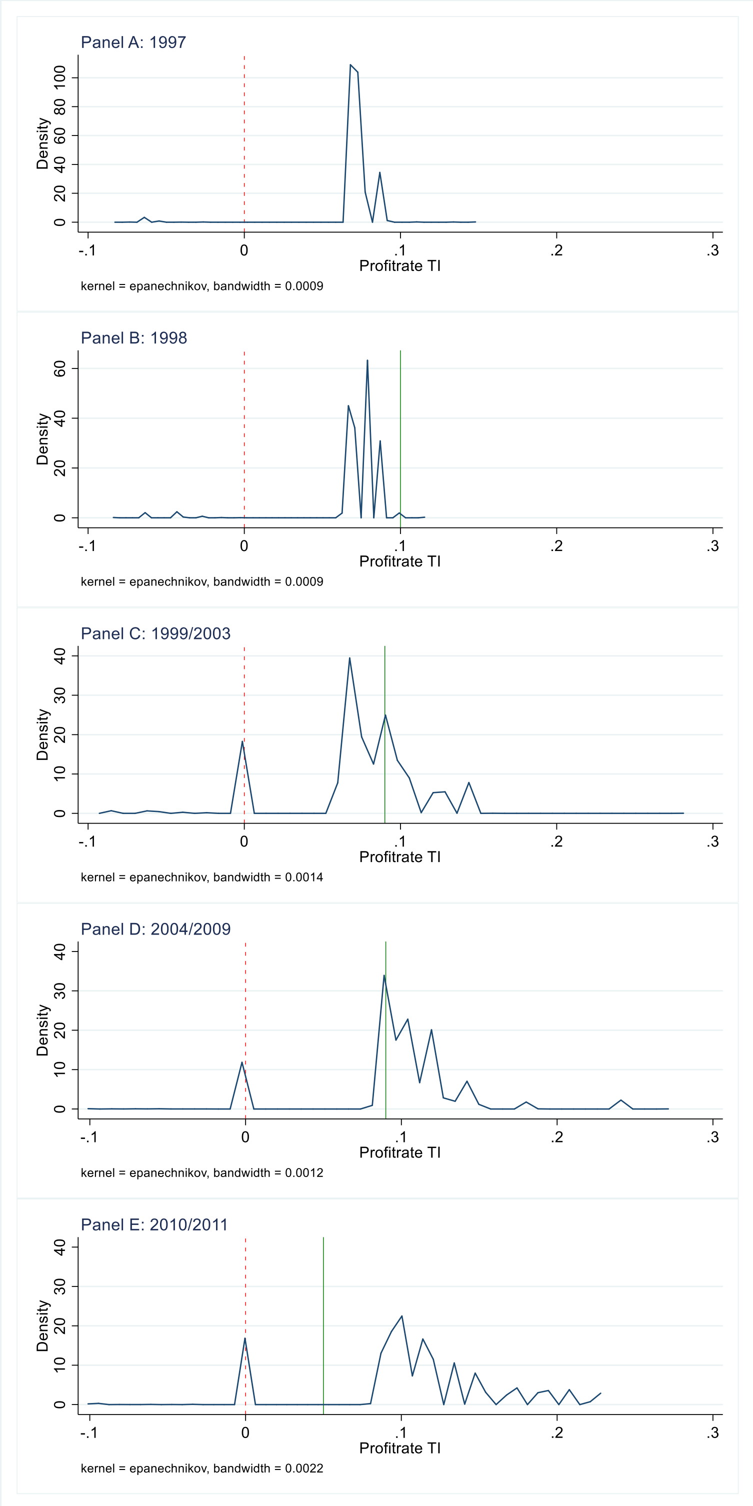
[26] One could argue that medium firms are more likely to be bunchers because they represent around 70% of all firms. However, this is not necessarily true. To identify bunchers, first I break down the distribution of all firms into eligible and non-eligible firms. Then, if I observe that the bunching originally detected in the distribution of all firms remains in the distribution of one of these subgroups, that subgroup is namely a buncher.

Figure 4.2: Bunching evidence, all firms



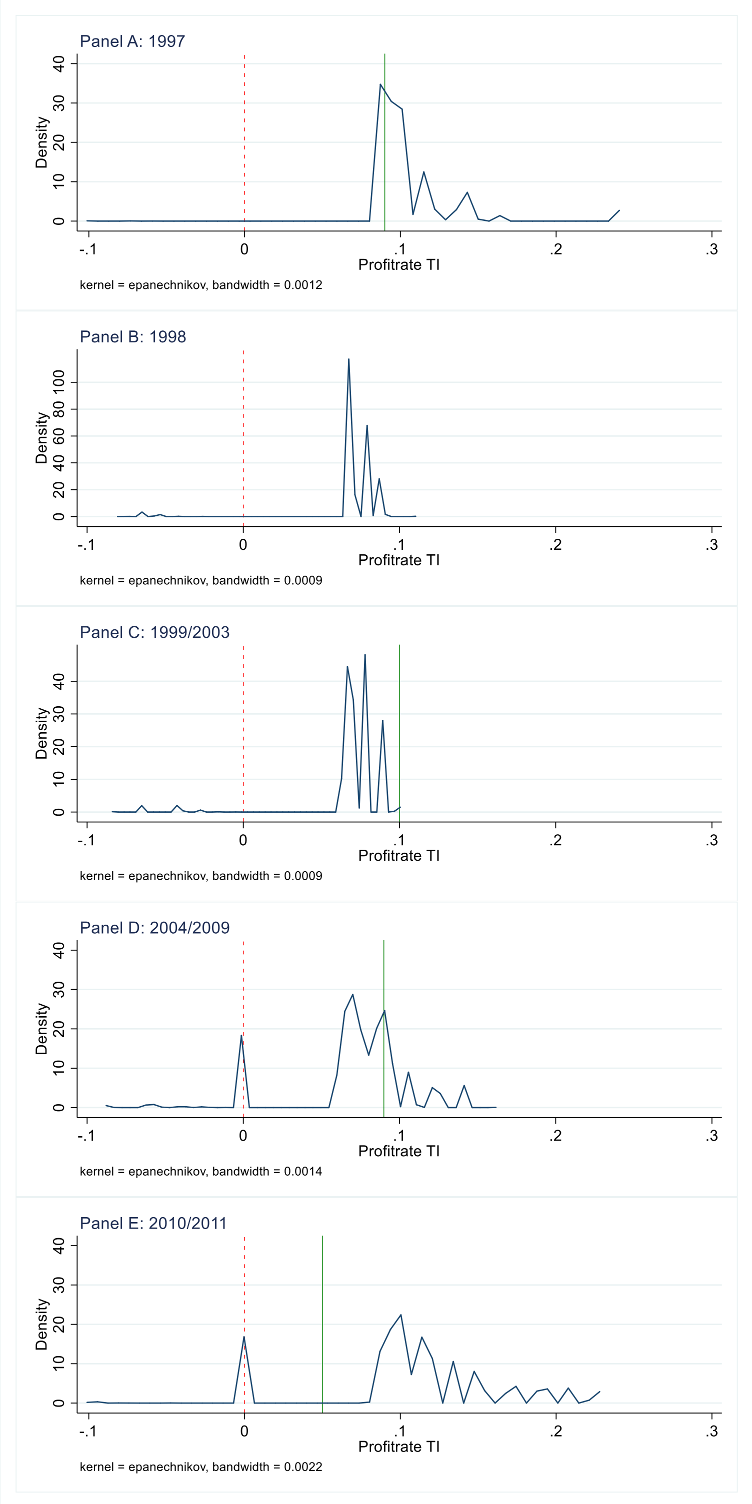
Notes: Figure 4.2 shows the empirical Kernel density distribution of the profit rate (*reported taxable income* as a fraction of turnover) for *all firms*. The green solid line shows the kink points calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05). The zero profit rate is marked by a dotted red line.

Figure 4.3: Bunching evidence, non-eligible firms



Notes: Figure 4.3 shows the empirical Kernel density distribution of the profit rate (*reported taxable income* as a fraction of turnover) for *non-eligible firms*. The green solid line shows the kink points calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05). The zero profit rate is marked by a dotted red line.

Figure 4.4: Bunching evidence, medium firms



Notes: Figure 4.4 shows the empirical Kernel density distribution of the profit rate (*reported taxable income* as a fraction of turnover) for *medium firms*. The green solid line shows the kink points calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05). The zero profit rate is marked by a dotted red line.

Table 4.2: Bunching estimates at kink points [a]

Years	Kink	Bandwidth	All (1)	Non eligible (2)	Medium (3)
Panel A: Bunching evidence					
1997	0.10	0.02	-0.49*	-0.73***	-0.73***
			(0.23)	(0.19)	(0.20)
1998	0.10	0.02	-0.78***	-0.75***	-0.75***
			(0.16)	(0.18)	(0.19)
1999/2003	0.09	0.02	0.17	0.14	0.14
			(0.13)	(0.14)	(0.14)
2004/2009	0.09	0.02	0.57***	0.57***	0.57***
			(0.09)	(0.09)	(0.09)
2010/2011	0.05	0.02	-1.00	-1.00	-1.00
			(0.00)	(0.00)	(0.00)
Panel B: Sensitivity analysis with bandwidth					
1997	0.10	0.01	0.13	-0.92**	-0.92**
			(0.50)	(0.23)	(0.23)
1998	0.10	0.01	-0.91**	-0.91**	-0.90*
			(0.21)	(0.21)	(0.30)
1999/2003	0.09	0.01	0.19	0.38**	0.38**
			(0.16)	(0.16)	(0.17)
2004/2009	0.09	0.01	0.43***	0.43***	0.43***
			(0.12)	(0.12)	(0.12)
2010/2011 [b]	0.05	0.01	-	-	-
1997	0.10	0.03	0.38	0.28	0.28
			(0.24)	(0.26)	(0.28)
1998	0.10	0.03	0.19	0.06	0.06
			(0.25)	(0.27)	(0.29)
1999/2003	0.09	0.03	0.82***	0.87***	0.87***
			(0.07)	(0.07)	(0.07)
2004/2009	0.09	0.03	0.78***	0.77***	0.78***
			(0.07)	(0.07)	(0.07)
2010/2011	0.05	0.03	-1.00	-1.00	-1.00
			(0.00)	(0.00)	(0.00)

Notes: Table 4.2 shows bunching estimates for the bunching detected in Figures 4.2-4.4. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] All firms (thresholds$[1-17]$), non-eligible firms (thresholds$[3-17]$) and medium firms (thresholds$[3-15]$).
[b] The bunching parameter cannot be estimated in 2010/2011 because of few observations.

4.5.2 Dynamics of bunching

Turning to the intuition that bunching represents mostly evasion responses, there are two elements which support it. First, Figures 4.5 - 4.7 show that bunching in 1997 is sharper than in any other year for all firms, non-eligible firms and medium firms[27]. In trying to explain the sharp bunching in 1997, one could call upon the foresight of firms. According to the reports of the tax administration (AFIP, 2006), the introduction of the SR is a response to the requests of small taxpayers made to the parliament of Argentina (probably based on the experience of Brazil where it was introduced in 1997). It is possible that Argentineans firms anticipated the policy and thus modified their behavior in 1997. This explanation requires the assumption that Argentineans firms have rational expectations and knew that the bill was being discussed in parliament. Another plausible explanation for the sharp bunching in 1997 is the case of potential endogeneity, the tax administration might have identified the profit rate where firms cluster and have used it as cutoff; in other words, the tax administration might have followed a methodology similar to ours to identify the cutoff that separates both regimes[28].

Bunching in 1998 (Fig. 4.5 – 4.7, Panel A) seems less surprising because although the implementation of the policy was in November 1998, it was approved by the parliament in June 1998 and announced in July 1998 through important advertising campaigns. Thus, firms could have modified their behavior from July 1998 to June 1999 (the last month for firms to present their tax returns to the tax administration). Nevertheless, it must be stressed that, by the time the tax changes were announced, most of the real decisions corresponding to the tax year 1998 had already been taken[29]. Given this, the speed of reaction provides supporting evidence that behavioral changes are driven by evasion responses rather than real responses. A similar reasoning is followed by Waseem (2013), Saez (1999) and Mosberger (2016), and this conclusion is further supported by the finding of Lediga *et al.* (2016, p.7) that it is difficult to adjust real output in a short period, because of adjustment costs and optimization frictions, e.g. existing long-term contracts. In short, the bunching observed in 1997 and in 1998 confirms that firms can rapidly adapt their compliance behavior.

The second element that support the intuition that bunching represent mostly evasion responses is the bunching detected around the zero profit rate[30] (Fig. 4.5 – 4.7, Panels B-D). Bunching at zero is probably due to the high prevalence of losses in taxable income (see Table A.1) and zero taxable income (which in turn may be partly explained by the generous deductions offered in Argentina)[31].

[27] No evidence is found for eligible (small firms) nor for large firms. See Figures D.1 and D.2.

[28] In line with this, Carrillo *et al.* (2014, p.9) pointed out that the reported profit rate is one of the key characteristics that the tax authority considers when determining whether to audit.

[29] Indeed, as Dekker *et al.* (2016, p.18) explained, "when pooling data, we observe some firms more than once; as a result, we attribute bunching behavior to those firms in every period, although the behavioral decision is made only once".

[30] In 1997 and 1998, there is no bunching around zero because no firms are reporting zero taxable income. Indeed, the tax returns of the CIT only allowed to report positive or negative taxable income, and this form of reporting only changed in 2001.

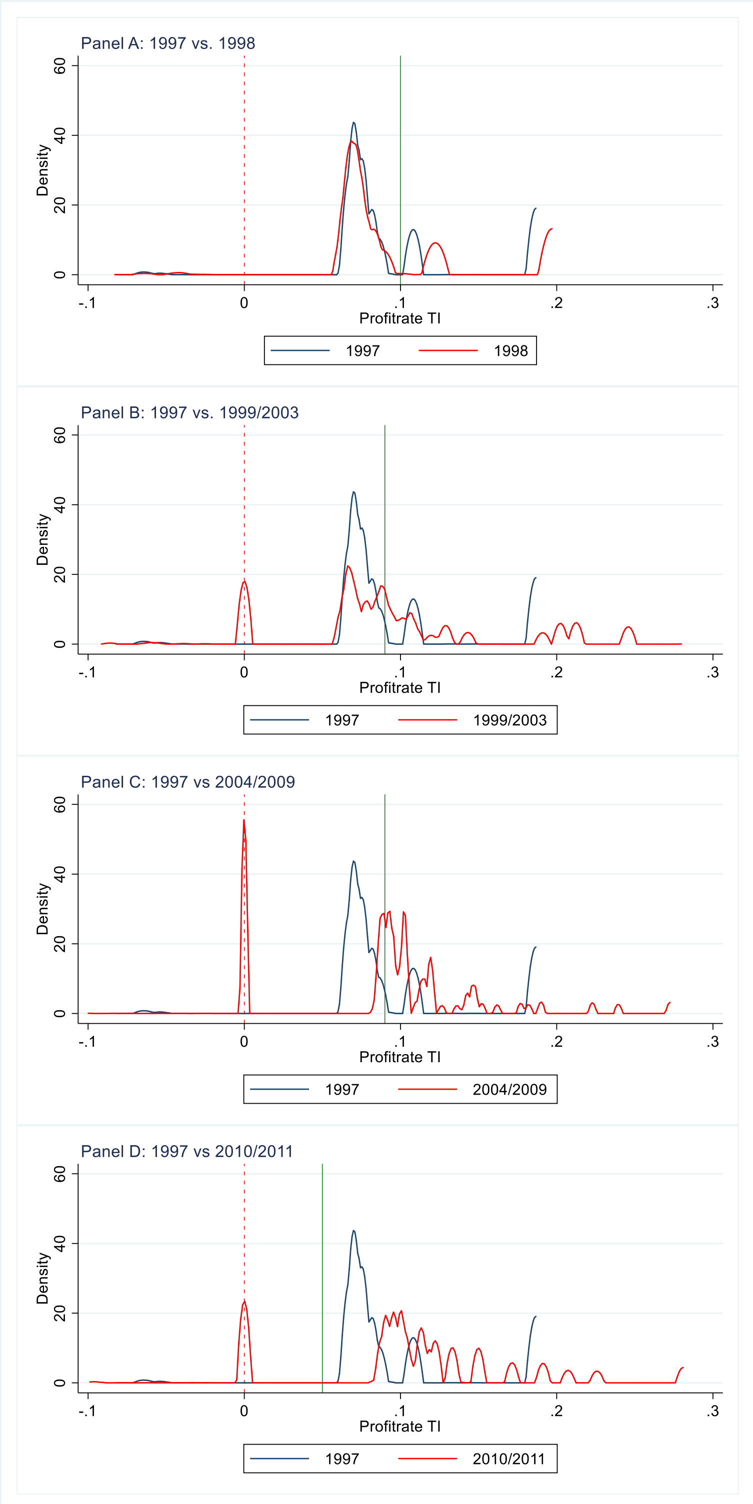
[31] In Argentina, firms can deduct for loss carry-forward, donations, differences in amortization, salaries to directors, expenditure of representation, contribution to private pension plans, etc. in accordance with the Law on Corporate Income Tax 649/97 (III, art.87).

This is quite common in developing countries. For example, Lediga *et al.* (2016) found bunching at zero income for small firms in South-Africa, due to loss carry-forward provisions. Another explanation is a response to tax incentives: the policy gives an incentive to under-report turnover, which in turn results in zero taxable income and hence a zero profit rate. Lastly, bunching at zero profit rate is driven mostly by medium firms (see Fig. 4.7 and Table 4.3, column (3))[32].

Finally, what are the insights that are provided by the reforms? Actually, they do not reveal much. First, the reform of December 1998 ($\Delta\tau_{\pi} > 0$) slightly decreased the kink point from 0.1 to 0.09. In Figure 4.5 (Panel A) the distribution does not move substantially. Also, the overlap of the effects of this reform with those of the introduction of the SR in November 1998 makes it difficult to distinguish any pattern in the data. Second, the reform of July 2004 ($\Delta\tau_{y} > 0$) increased the turnover tax rate of the highest categories in the SR. Because the turnover tax rate of the lowest category is used, the kink point is not affected. Finally, the third reform of December 2009 ($\Delta\tau_{y} < 0$) reduces the kink point from 0.09 to 0.05. In Figure 4.5 (Panel D) bunching remains on the right of the kink which suggests that firms are not responding to this last reform. Nevertheless, a broad overlook to the data (Table A.3) shows that the number of firms and subsequently the amount of turnover and taxable income decreased dramatically in the years after 1998. This effect is detected specially among medium and large firms, because small firms follow the contrary path. On the other side, in the years following the tax reforms of 2004 and 2009 the number of firms, turnover and taxable income decreased only among small firms.

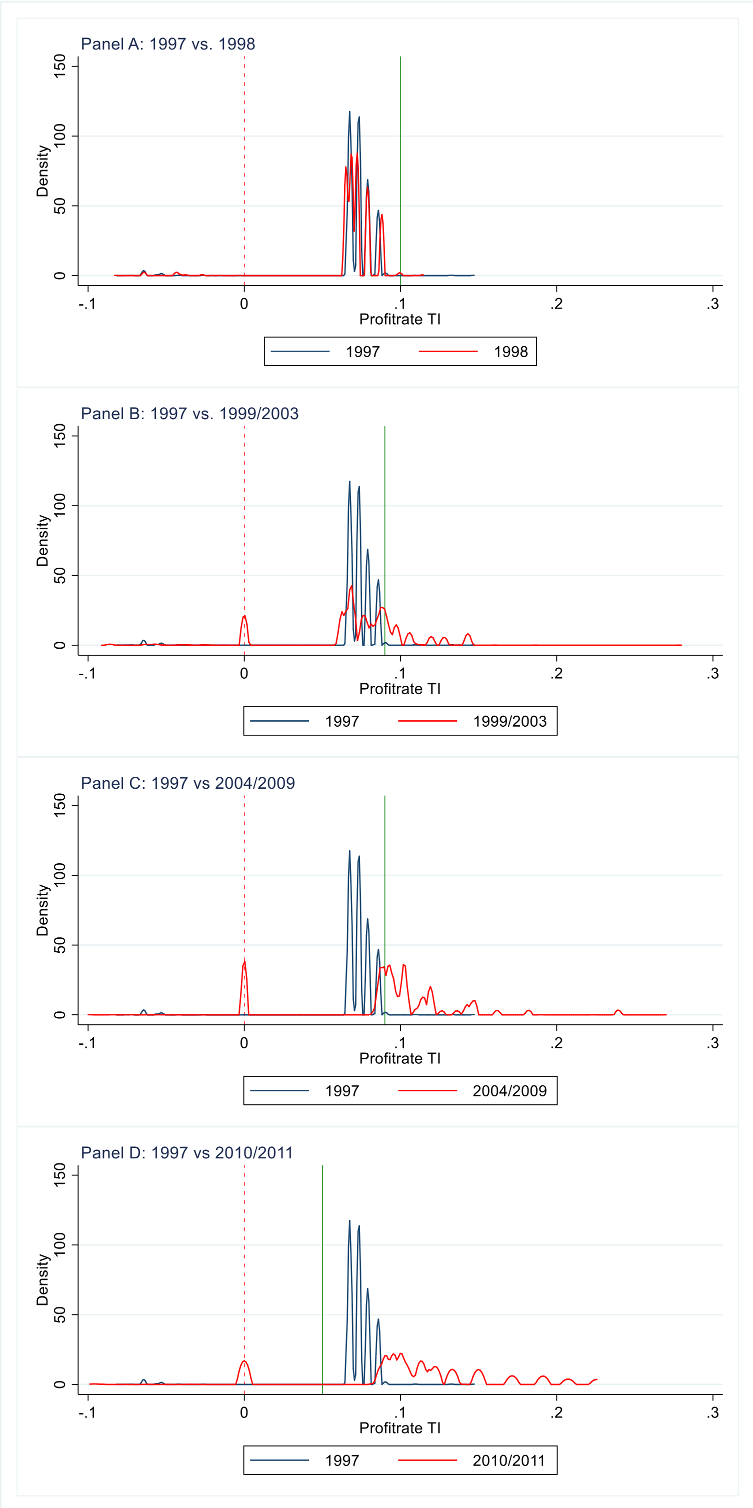
[32] No evidence is found for eligible (small firms), see Fig. D.1. For large firms, evidence is not consistent, see Fig. D.2.

Figure 4.5: Dynamics of bunching, all firms



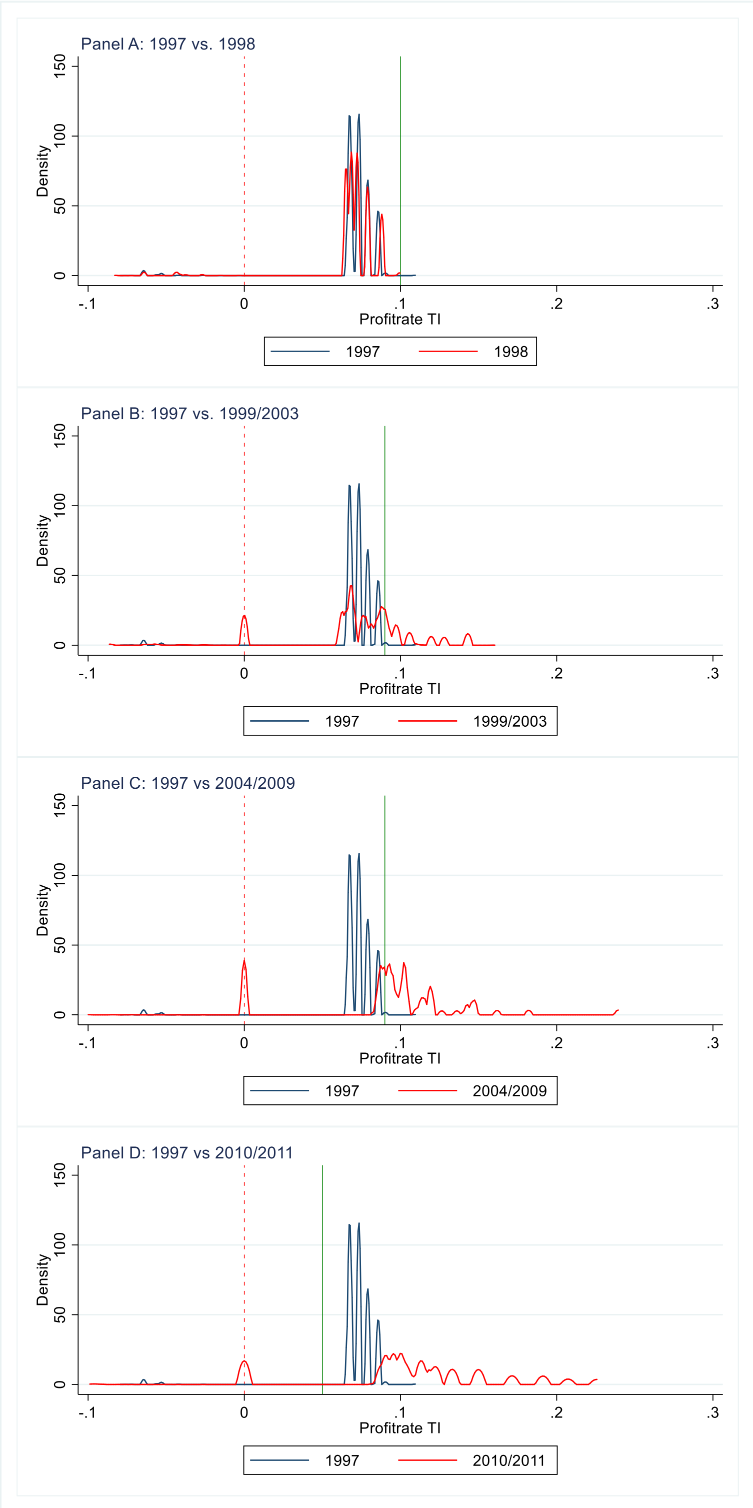
Notes: Figure 4.5 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *all firms* in 1997, 1998, 1999/2003, 2004/2009 and 2010/2011. The green solid line shows the profit rates calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05), and the zero profit rate is marked by a dotted line.

Figure 4.6: Dynamics of bunching, non-eligible firms



Notes: Figure 4.6 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *non-eligible firms* in 1997, 1998, 1999/2003, 2004/2009 and 2010/2011. The green solid line shows the profit rates calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05), and the zero profit rate is marked by a dotted line.

Figure 4.7: Dynamics of bunching, medium firms



Notes: Figure 4.7 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *medium firms* in 1997, 1998, 1999/2003, 2004/2009 and 2010/2011. The green solid line shows the profit rates calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05), and the zero profit rate is marked by a dotted line.

Table 4.3: Bunching estimates at zero [a]

Years	Bandwidth	All (1)	Non eligible (2)	Medium (3)
Panel A: Bunching evidence				
1999/2003	0.02	0.97***	0.95***	0.94***
		(0.03)	(0.05)	(0.05)
2004/2009	0.02	1.00***	1.00***	1.00
		(0.01)	(0.01)	(0.00)
2010/2011	0.02	0.99***	0.99***	1.00
		(0.02)	(0.03)	(0.00)
Panel B: Sensitivity analysis with bandwidth				
1999/2003	0.01	1.00***	1.00***	1.00***
		(0.01)	(0.01)	(0.01)
2004/2009	0.01	1.00	1.00	1.00
		(0.00)	(0.00)	(0.00)
2010/2011	0.01	1.00	1.00	1.00
		(0.00)	(0.00)	(0.00)
1999/2003	0.03	0.93***	0.87***	0.87***
		(0.05)	(0.07)	(0.08)
2004/2009	0.03	1.00***	0.99***	1.00***
		(0.01)	(0.01)	(0.01)
2010/2011	0.03	0.99***	0.99***	1.00***
		(0.02)	(0.03)	(0.02)

Notes: Table 4.3 shows bunching estimates at zero detected in Figures 4.5 – 4.7. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] All firms (thresholds$[1-17]$), non-eligible firms (thresholds$[3-17]$) and medium firms (thresholds$[3-15]$).
[b] Note that in 1997 and 1998, there is no bunching around zero because no firms are reporting zero taxable income.

4.5.3 Robustness checks

Figure 4.8 shows that at the beginning of the period under study (in 1998), firms bunch below the kink point $\tau_y(min.)/\tau_\pi$, in 1999/2003 the bunch is placed around the kink point, in 2004/2009 exactly at the kink point and in 2010/2011 above it. This is so for non-eligible firms (Figure 4.9) and medium firms (Figure 4.10)[33]. The finding that bunching becomes more centered on the kink point 0.09 over time may indicate that firms slowly adapt their real output behavior and provides compelling evidence that firms learn over time. Bunching translates graphically not into a clear spike at the kink point but instead into a diffuse mass around it. In other words, there is asymmetric bunching which is sometimes below the kink, other times at the kink and others above it.

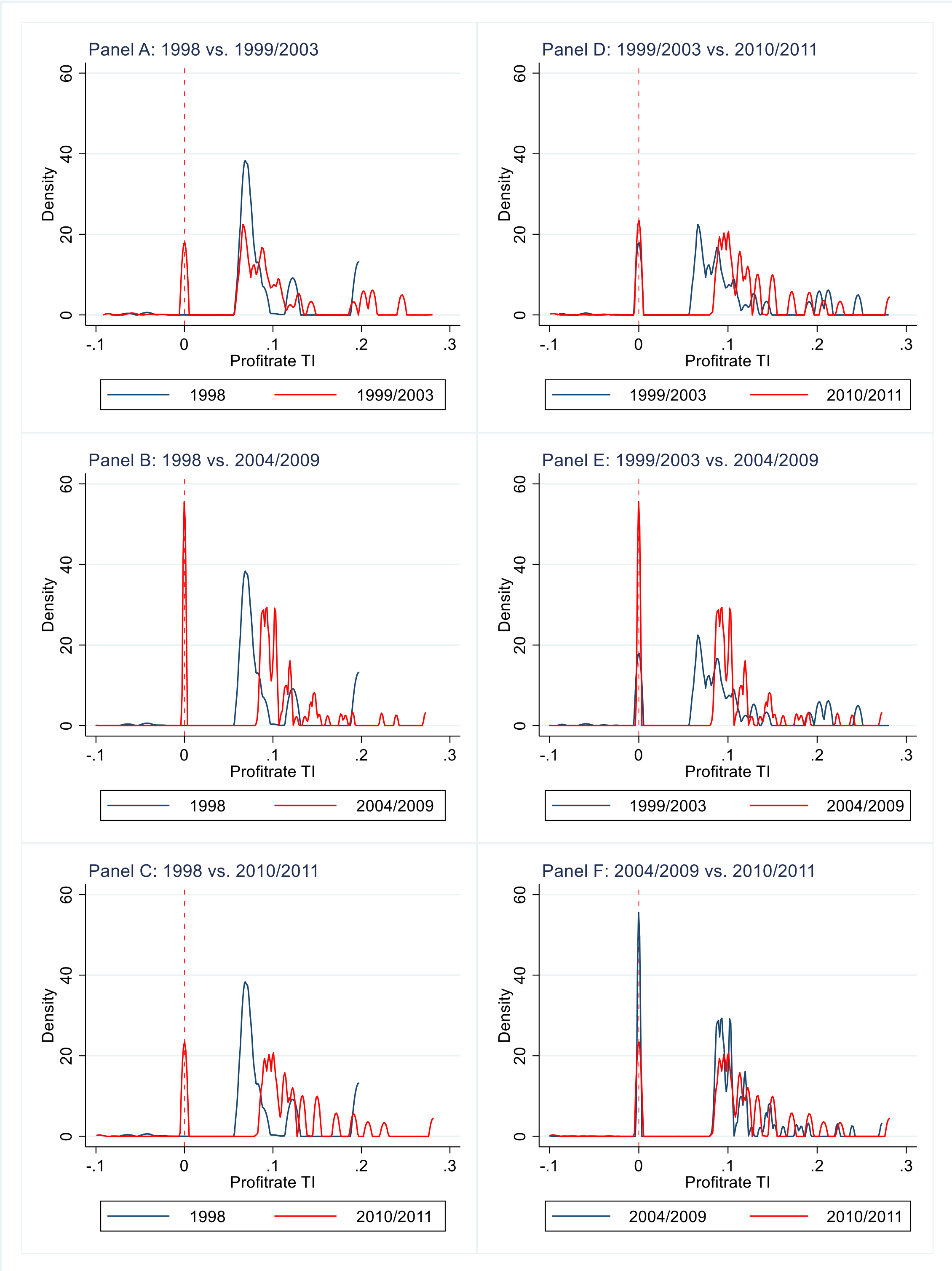
[33] This result is not observed for eligible (small) firms nor for large firms, see Fig. E.1 and E.2.

Moreover, Table 4.4 shows that bunching is predominantly around 0.09, which provides strong evidence that firms respond to the tax structure. Indeed, it is difficult to see a reason for firms to cluster around a profit rate of 0.09 other than the presence of the SR. An argument in the empirical bunching literature that can shed light on these findings is the 'reference-point'. Kleven (2016, p.23) pointed out that the creation of a threshold which separates both regimes makes firms consider the 0.09 threshold as a reference point introduced by the policy. For example, Mosberger (2016) explained the Hungarian asymmetric bunching with this reasoning, arguing that, in countries where the tax authority is not credible, firms bunch above the threshold to avoid being audited[34].

To conclude this section, three main findings are worth pointing out. First, results show bunching around the kink point specially among medium firms, which confirms that the policy indirectly affects firms in the GR. Second, there is a slight bunching around zero and sharp bunching in 1997 and 1998, both results suggest that bunching is mostly due to evasion responses rather than real output responses. Finally, consistent with our original hypothesis, I observe an asymmetric bunching around a profit rate of 0.09 which provides strong evidence that firms respond to the policy. Unfortunately, the lack of data prevents from continuing with the analysis and estimating the magnitude of the responses.

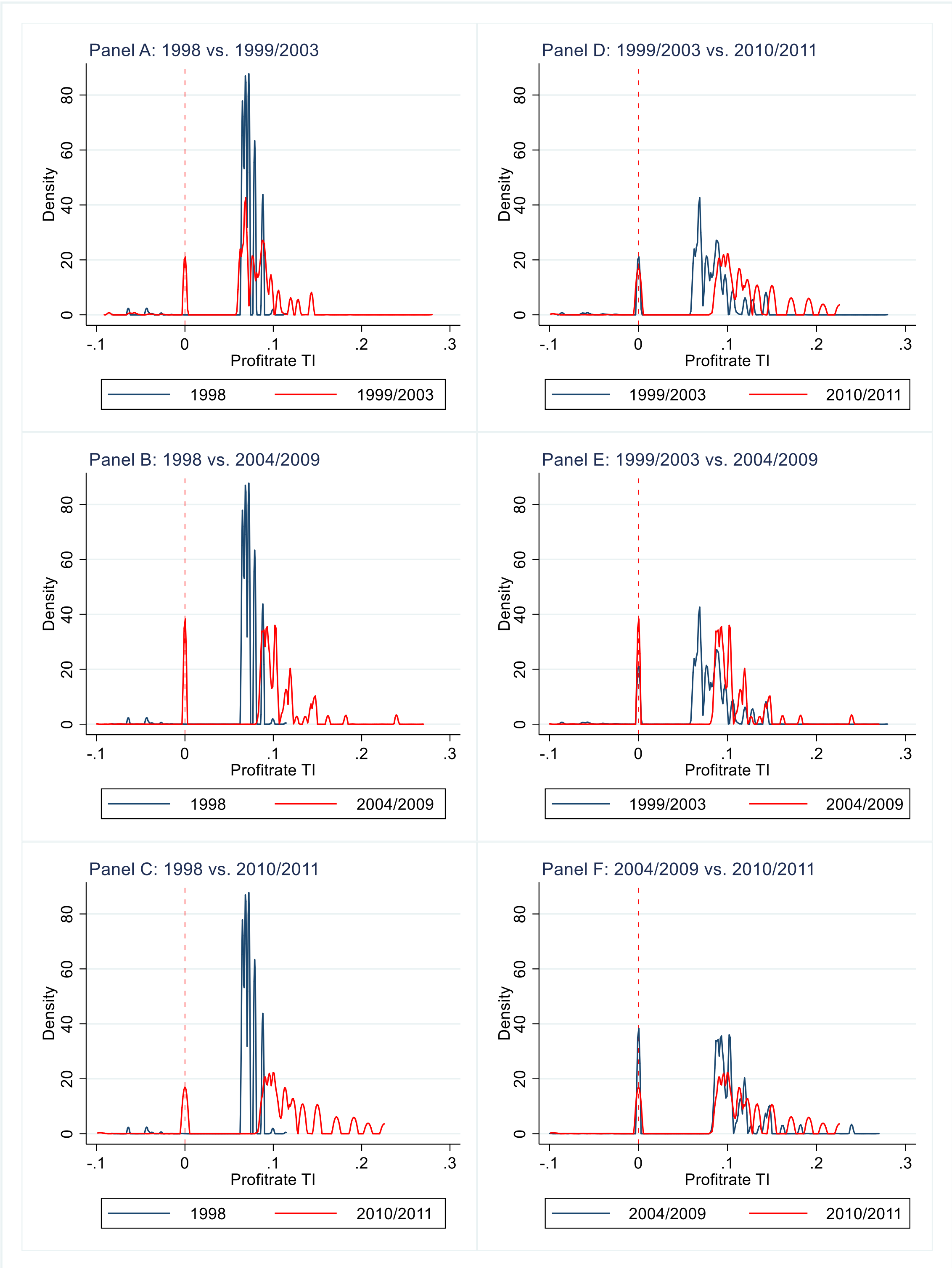
[34] This line of argumentation supports the idea of Castro and Scartascini (2015) that suggested that the level of compliance also depends on individual's subjective beliefs about the levels of enforcement and penalties, the behavior of other taxpayers, etc.

Figure 4.8: Robustness checks, all firms



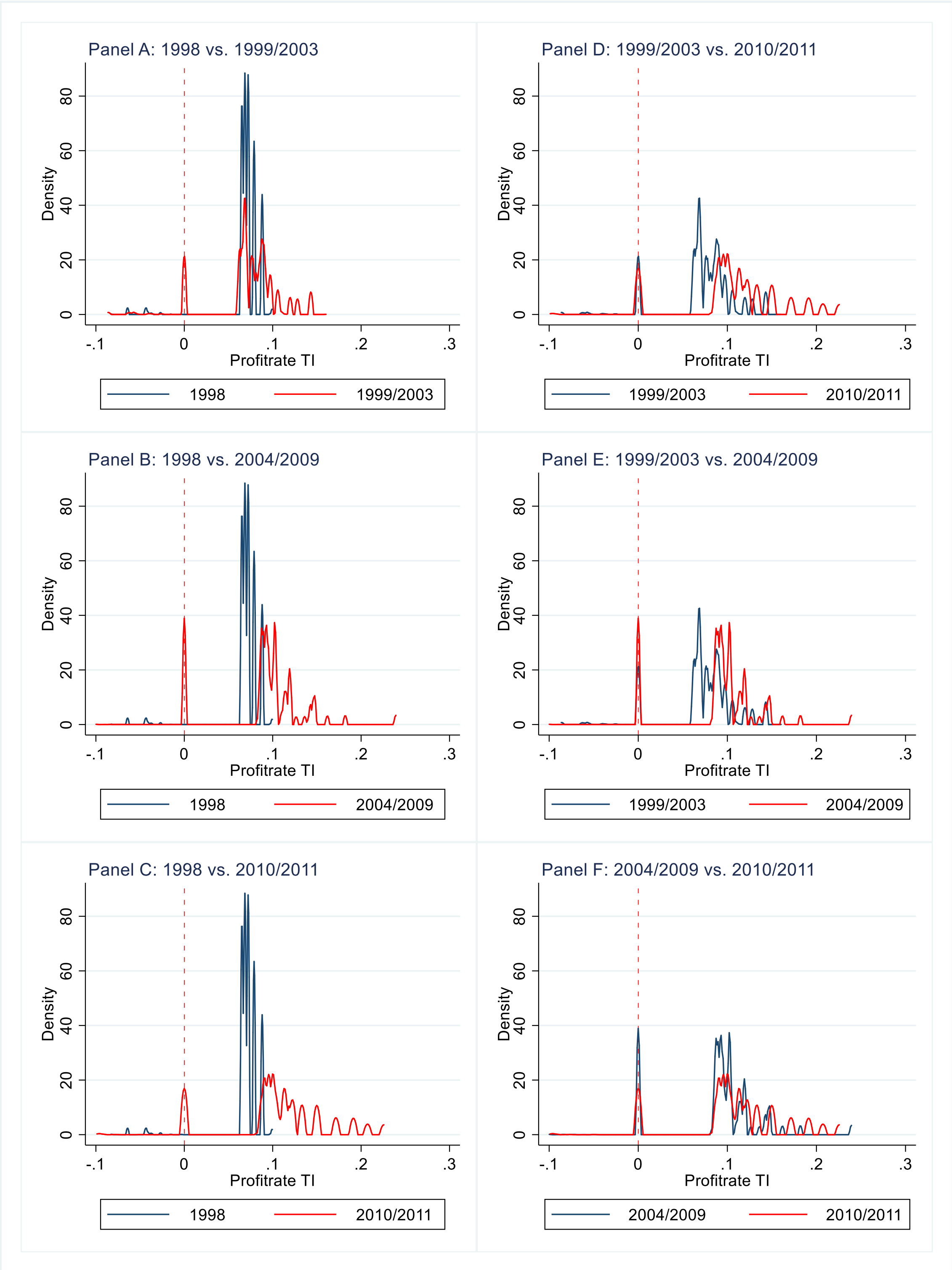
Notes: Figure 4.8 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *all firms* in each time period. The kinks are at a profit rate: 0.1 (in 1998), 0.09 (in 1999/2003), 0.09 (in 2004/2009) and 0.05 (in 2010/2011).

Figure 4.9: Robustness checks, non-eligible firms



Notes: Figure 4.9 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *non-eligible firms* in each time period. The kinks are at a profit rate: 0.1 (in 1998), 0.09 (in 1999/2003), 0.09 (in 2004/2009) and 0.05 (in 2010/2011).

Figure 4.10: Robustness checks, medium firms



Notes: Figure 4.10 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *medium firms* in each time period. The kinks are at a profit rate: 0.1 (in 1998), 0.09 (in 1999/2003), 0.09 (in 2004/2009) and 0.05 (in 2010/2011).

Table 4.4: Bunching estimates at 0.09 [a]

Years	Kink	Bandwidth	All (1)	Non eligible (2)	Medium (3)
1997	0.09	0.01	-0.67**	-0.59*	-0.59*
			(0.25)	(0.29)	(0.29)
1998	0.09	0.01	-0.53	-0.53	-0.53
			(0.34)	(0.38)	(0.38)
1999/2003	0.09	0.01	0.19	0.38**	0.38**
			(0.16)	(0.16)	(0.17)
2004/2009	0.09	0.01	0.43***	0.43***	0.43***
			(0.12)	(0.12)	(0.12)
2010/2011	0.09	0.01	0.48**	0.48**	0.49**
			(0.21)	(0.21)	(0.22)

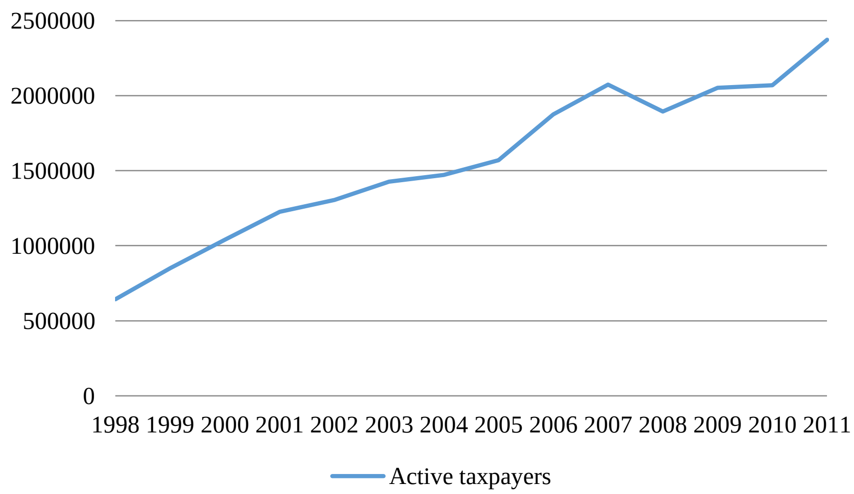
Notes: Table 4.4 shows bunching estimates at 0.09 profit rate detected in Figures 4.8 – 4.10. Standard errors are in parentheses; all are computed using the delta method. Significance levels are *** p<0.01, ** p<0.05, * p<0.1.
[a] All firms (thresholds$[1-17]$), non-eligible firms (thresholds$[3-17]$) and medium firms (thresholds$[3-15]$).
[b] The bandwidth selected captures best the result and estimates are consistent with what is visually detected.

4.6 Discussion

In this last section, I present some general information about the SR that I unfortunately did not have access to. As mentioned earlier, the policy had two motivations: to fight informality and to reduce evasion. It seems that these became the main concerns of the Argentinean tax administration because informality and the number of self-employed individuals increased sharply in the 1970s. Small firms are often associated with subsistence and home-based entrepreneurship, as well as low education levels. These firms cover a significant part of all salaried employment. For instance, in 2011, firms of up to 5 employees contributed to 19% of the total employment, and firms of 6 to 25 employees contributed to another 19% (Van Elk and Kok 2014, p.47). In addition, the tax administration reports (AFIP, 2006) refer to the existence of 'involuntary informality' as a result of a complex tax system and high administrative costs[35]. Unsurprisingly, there are few studies about tax evasion in Argentina due to the limited data availability. The study of Gómez and Jiménez (2011, p.29) estimated a tax evasion rate of 21.2% for VAT in 2006 and of 49.7% for income tax in 2005. Since its implementation, the SR was successful in attracting taxpayers, as shown in Fig. 4.11: the number of active taxpayers registered in the regime continuously increased and it almost quadrupled in the period under study, from 642 167 in 1998 to 2 371 469 in 2011.

[35] According to "Doing business 2014" (World Bank), Argentina is ranked on the 126 position over 189 countries in the ease of registering a business. Source: http://www.doingbusiness.org/en/data/exploreeconomies/argentina#

Figure 4.11: Active taxpayers in the simplified regime



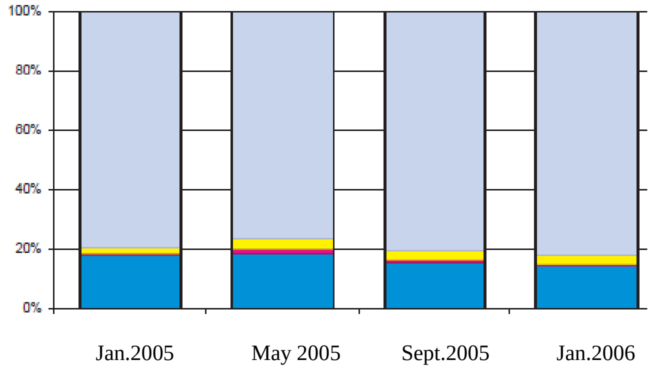
Source: Based on ILO (2013, p.41)

More importantly, the ILO reports (ILO 2013, p.42) showed that the majority of active taxpayers in the SR are from the service and commercial sectors. For example, in 1999, 40.7% of the total number of the registered taxpayers was from the service sector and 34.2% was from the commercial sector. In 2005, the percentages had increased to 67.4% and 28.7%, and in 2013 they had decreased slightly to 61.9% and 18.6%, respectively. Conversely, the minority of registered taxpayers are from the industrial and farming sectors. This is likely due to the fact that these sectors engage in trade with firms registered in the GR, which have a disincentive to carry out transactions with taxpayers in the SR, because deducting VAT credits from purchases is not possible in that case.

Furthermore, the reports of the tax administration (AFIP, 2006) showed that, in February 1999 (four months after the implementation of the policy), there were nearly 777 605 taxpayers which had registered in the regime and that, by the end of 1999, the number increased to almost one million taxpayers. According to the reports, 90% of those newcomers were classified in the lowest categories and around 2% in the highest categories. The ILO (2013, p.43) highlighted that such numbers continued until 2013: 46% of taxpayers were from the lowest category in 2005 and 54.7% in 2013; whereas only 0.2% of the taxpayers were from the highest category. The agglomeration of taxpayers in the lowest categories of the SR confirms the hypothesis that there exist "icebergs" in the SR, i.e. firms who under-report turnover in order to be classified in the lowest categories. As a consequence, there are frequent re-categorizations towards higher categories, as can be observed in Fig. 4.12, 79.8% of firms were re-categorized to a higher category in 2005, 82.3% in 2006, 86.7% in 2007, 87.6% in 2008 and 79% in 2009. By contrast, 17.9% of firms were re-categorized to a lower category in 2005, 14.4% in 2006, 10.8% in 2007, 9.2 % in 2008 and 13.4% in 2009 (ILO

2014:39). Also, the reports confirmed that 95.1% of firms registered in 1998 in the SR were from the GR, while only 4.9% were informal firms. Of these 95.1%, 83.8% were "icebergs" in the GR, while only 16.2% were fully taxpayers. Finally, in 2006, 11.4% of taxpayers registered in the income tax moved to the SR, yet surprisingly their participation in the income tax revenue was only 0.8%[36] (Van Elk and Kok 2014, p.50).

Figure 4.12: Re-categorization in the Simplified Tax Regime



Notes: Dark blue corresponds to a re-categorization to a lower category, yellow corresponds to a move from the SR to the VAT, red corresponds to a move from the SR to a sub-regime of the SR for eventual taxpayers and grey corresponds to a re-categorization to a higher category. Source: Report (AFIP June 2006, p.14)

Consequently, despite the high number of active taxpayers in the SR, the tax revenue collected is minimal[37] (see Table A.1). This is probably because of the elevated evasion in the regime and because it concerns mostly small taxpayers with very low income. The tax administration reports (AFIP, 2006) also suggested that the amount of payments in the SR steadily decreased until 2002 and started increasing only after 2004. Furthermore, many features affect the revenue collected through the SR, such as the economic cycle, the inflation and the degree of development. The reports (AFIP, 2006, p.10) estimated a coefficient of correlation between the amount of payments and the real GDP of 0.84 and between the tax revenue and the real GDP of 0.83 for 1998-2006. Inflation also affects the SR through prices and wages. For this reason, the ILO (2014) suggested that the scarcity of information about the SR may be due to its instability, (the single tax was continuously updated by the tax administration). Moreover, the ILO (2013) indicated that the cities with high HDI and less informality have a higher number of firms registered in the simplified regime.

[36] For the VAT, Van Elk and Kok (2014, p.50) indicate that only 2.5% of taxpayers registered in the VAT moved to the SR, their payments were only 0.1% of the VAT revenue and 61.1% did not register any payment in 2006.

[37] 70% of the revenue collected from the SR is destined to the ANSES (National Administration of Social Security) and 30% is set aside for provincial jurisdictions according to the partnership's tax regime (Van Elk and Kok 2014, p.47).

Finally, the reports of the ILO (2013, 2014) raised a crucial issue about this policy in Argentina with further strengthens our findings. The SR stopped being a “transitory regime” towards formality, a short-term policy implemented to motivate a ‘smoother’ transition of informal firms to formality. Indeed, the weak entry barriers of the SR became strong exit barriers. As the ILO (2013, 2014) claimed, the SR became a "trap" where small taxpayers are encouraged to remain indefinitely small in order to take advantage of the regime, although most of them have the capacity to register in the GR. In other words, the SR becomes a shelter for “icebergs”, impeding their transition to the GR. Thus, the SR is harmful to both tax revenue and production efficiency because it decreases the revenue that can be collected by the GR and gives incentives to firms in both regimes to under-report turnover. The ILO (2013, 2014) rightly argues that the SR should be understood as a short-term policy, and that attention should be paid to the process of "exiting" the SR.

4.7 Conclusions

In this study I analyzed the trade-off between production and revenue efficiency faced by governments in developing countries. In order to do so, I selected a production inefficient policy, the simplified regime, applied in all Latin America. Under this regime, firms are taxed based on their turnover and have access to social security benefits. I drew upon Best *et al.* (2014), who model the trade-off in the presence of evasion, and I introduced turnover evasion to better approximate the economic reality in Argentina. The optimality conditions suggest that, in countries with limited tax capacity, it may be desirable to deviate from full production efficiency in order to reduce evasion. I analyzed this empirically using the bunching approach, relying on the idea that firms are taxed either on their profits or on their turnover depending on which tax liability is larger. Results are not as robust as I hoped, due to the two limitations of the data. However, they do provide bunching evidence and help to shed light on the corporate tax situation in Argentina, which will be helpful for future research.

The objective of this study was to analyze empirically the trade-off between revenue and production efficiency in the choice of tax instruments in a developing country. Is there indeed any trade-off between revenue and production efficiency in the SR of Argentina? Theoretically, the regime should reduce the number of “ghosts” and “icebergs”, and hence increase revenue efficiency (welfare gain) while reducing production efficiency (welfare loss). However, in practice these results are not so clear. In fact, I showed that turnover evasion played a crucial role in explaining the results. It is not so obvious that the SR increases compliance at the expense of production efficiency, so that the trade-off in Argentina is not as clear as in the case of Pakistan analyzed by Best *et al.* (2014). All in all, the asymmetric bunching observed among firms in the GR suggests that the policy might indirectly affect the real and compliance behavior of firms in the GR by giving them an additional incentive to evade taxation.

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Supplemental material Chapter 4

4.A Descriptive statistics

Table A.1: Summary statistics

	1997	1998	1999	2000	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011
Panel A: Tax Variables														
Profit Tax Rate	0.33	0.33	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35	0.35
Turnover Tax Rate (Min.)	-	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.02	0.02
CIT Revenue (%GDP)	2.85	3.18	3.26	3.67	2.85	3.92	4.98	5.27	5.14	5.28	5.17	4.85	5.31	5.9
Total Tax revenue (%GDP)	13.37	13.72	14.10	13.38	11.49	13.65	16.08	16.29	16.22	16.88	16.67	16.47	17.51	18.27
SR Revenue (%GDP)	-	-	0.14	0.12	0.07	0.08	0.11	0.14	0.13	0.13	0.13	0.14	0.15	0.16
SR Revenue (%TotGovRev)	-	-	0.81	0.72	0.44	0.39	0.51	0.63	0.58	0.53	0.50	0.51	0.51	0.55
Panel B: Firm Characteristics (Mean)														
Taxable Income (thousands, pesos)	262	269	232	274	1 382	513	432	487	541	696	842	852	1 032	1 271
Profits (thousands, pesos)	769	890	735	803	1 408	1 316	1 322	1 553	1 737	2 204	2 502	2 638	3 266	4 148
Turnover (thousands, pesos)	2 632	2 968	2 413	2 554	4 210	4 370	4 271	5 010	5 637	7 334	8 550	8 604	10 589	13 716
Total number of firms	105 721	102 617	104 193	103 706	93 661	92 699	132 032	133 639	152 429	140 135	159 995	172 385	176 387	182 577
Firms reporting gains	59 791	58 220	56 097	54 139	43 437	49 797	71 380	78 551	94 244	93 735	109 498	115 477	123 878	133 746
Firms reporting losses	1 704	1 881	2 257	2 334	36 242	27 458	34 297	30 591	32 203	26 132	29 640	36 471	30 829	28 297
Observations	61 495	60 101	58 354	56 473	93 661	92 699	132 032	133 639	152 429	140 135	159 995	172 385	176 387	182 577

Notes: Table A.1 presents descriptive statistics, focusing on tax variables (panel A) and firm characteristics (panel B) from the GR. Sources: Argentinean Laws No. 24977, 25865, 26565, Federal Administration of Public Revenue, Dataset (AFIP) and ILO (2014, p.42).

Table A.2: Classification of firms in the general regime

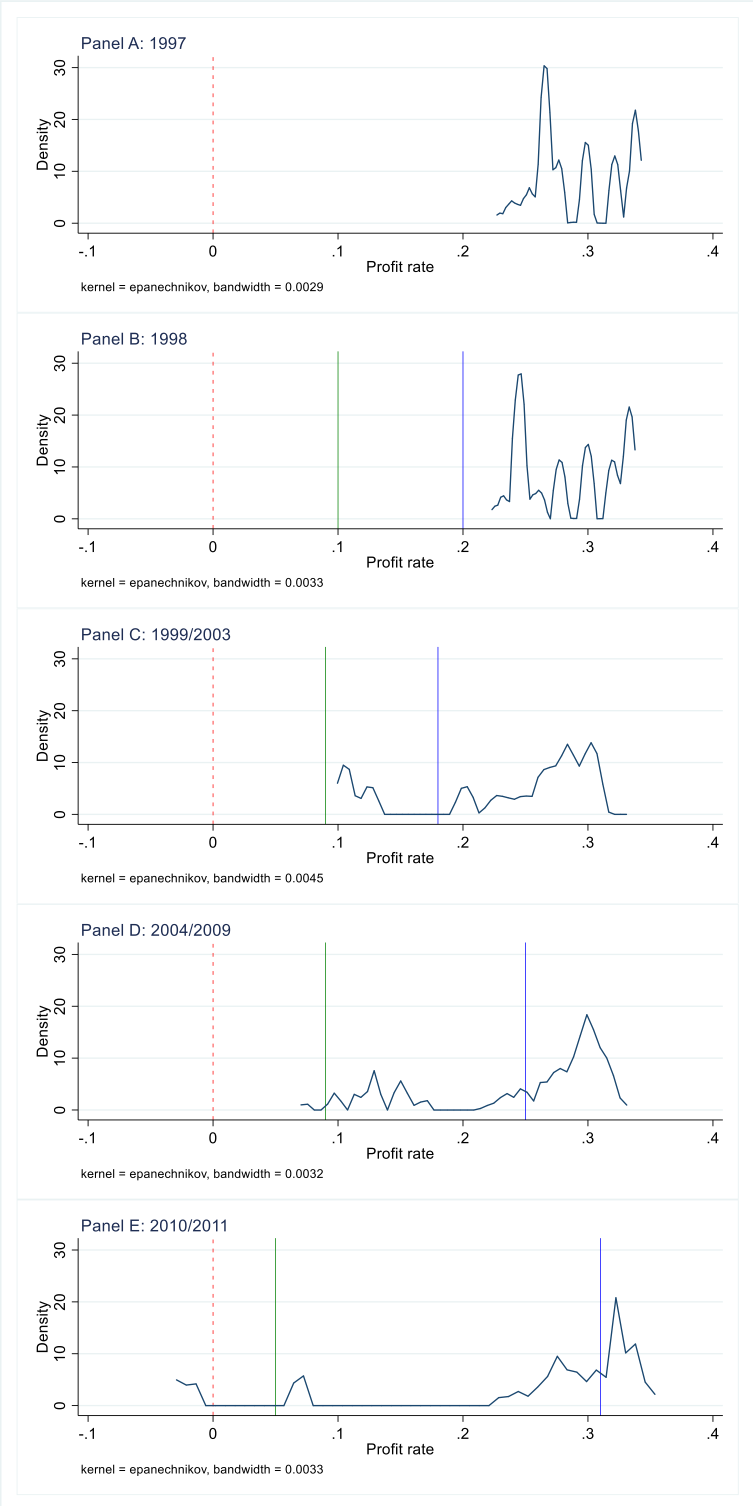
Threshold	Reported turnover (annual, pesos)		Size	Eligibility
1º	1	100 000	Small firms	Eligible firms
2º	100 001	200 000		
3º	200 001	300 000	Medium firms	Non eligible firms
4º	300 001	500 000		
5º	500 001	1 000 000		
6º	1 000 001	2 000 000		
7º	2 000 001	3 000 000		
8º	3 000 001	5 000 000		
9º	5 000 001	10 000 000		
10º	10 000 001	20 000 000		
11º	20 000 001	30 000 000		
12º	30 000 001	50 000 000		
13º	50 000 001	100 000 000		
14º	100 000 001	200 000 000		
15º	200 000 001	300 000 000		
16º	300 000 001	500 000 000	Large firms	
17º	More than 500 000 000			

Table A.3: Growth rates

Firm's size	Tax thresholds	1997/1998	1998/1999	2004/2005	2009/2010	2010/2011
Panel A: Number of firms						
Small	1 to 2	-8%	7%	-8%	-8%	-12%
Medium	3 to 15	0%	-7%	7%	6%	8%
Large	16 to 17	18%	-6%	15%	27%	34%
Total	1 to 17	-2%	-3%	1%	2%	4%
Panel B: Amount of reported turnover						
Small	1 to 2	-14%	18%	-14%	-14%	-21%
Medium	3 to 15	6%	-15%	25%	25%	39%
Large	16 to 17	24%	-38%	48%	73%	93%
Total	1 to 17	4%	-13%	23%	26%	42%
Panel C: Amount of reported taxable income						
Small	1 to 2	-6%	13%	-15%	-17%	-12%
Medium	3 to 15	2%	-22%	26%	25%	47%
Large	16 to 17	9%	-20%	38%	69%	73%
Total	1 to 17	2%	-20%	17%	25%	46%

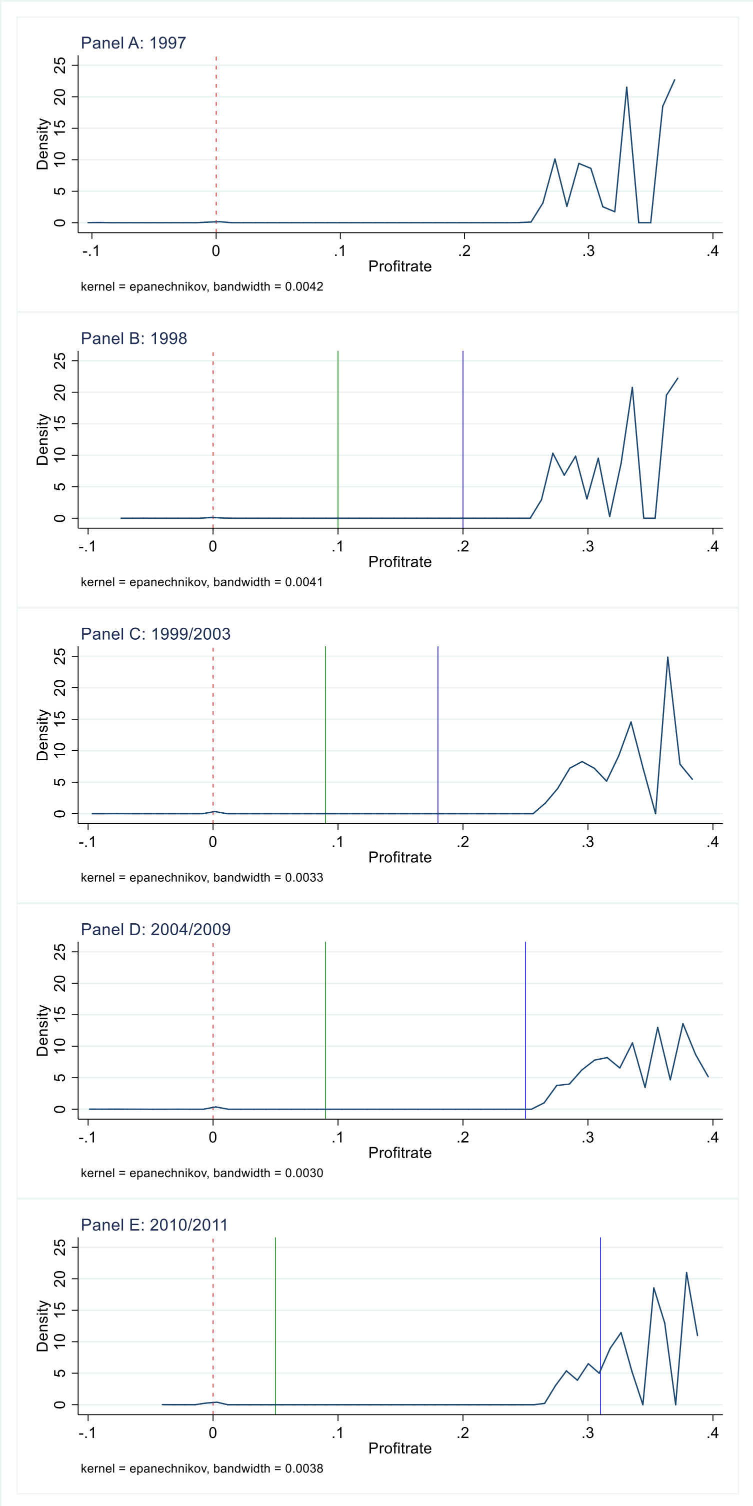
4.B Identification checks

Figure B.1: Identification check, calculated profit



Notes: Fig. B.1 shows the empirical Kernel density distribution of the profit rate (*calculated profit* as a fraction of turnover) for all firms and different time periods. The calculated profit is the reported turnover minus the reported costs. The zero profit rate is marked by a dotted red line. The green solid line shows the kink points calculated using $\tau_y(\min)$ and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05). The blue solid line shows the kink points calculated using $t_y(total, \min)$ and τ_π: 1998(0.2), 1999/2003(0.18), 2004/2009(0.25) and 2010/2011(0.31).

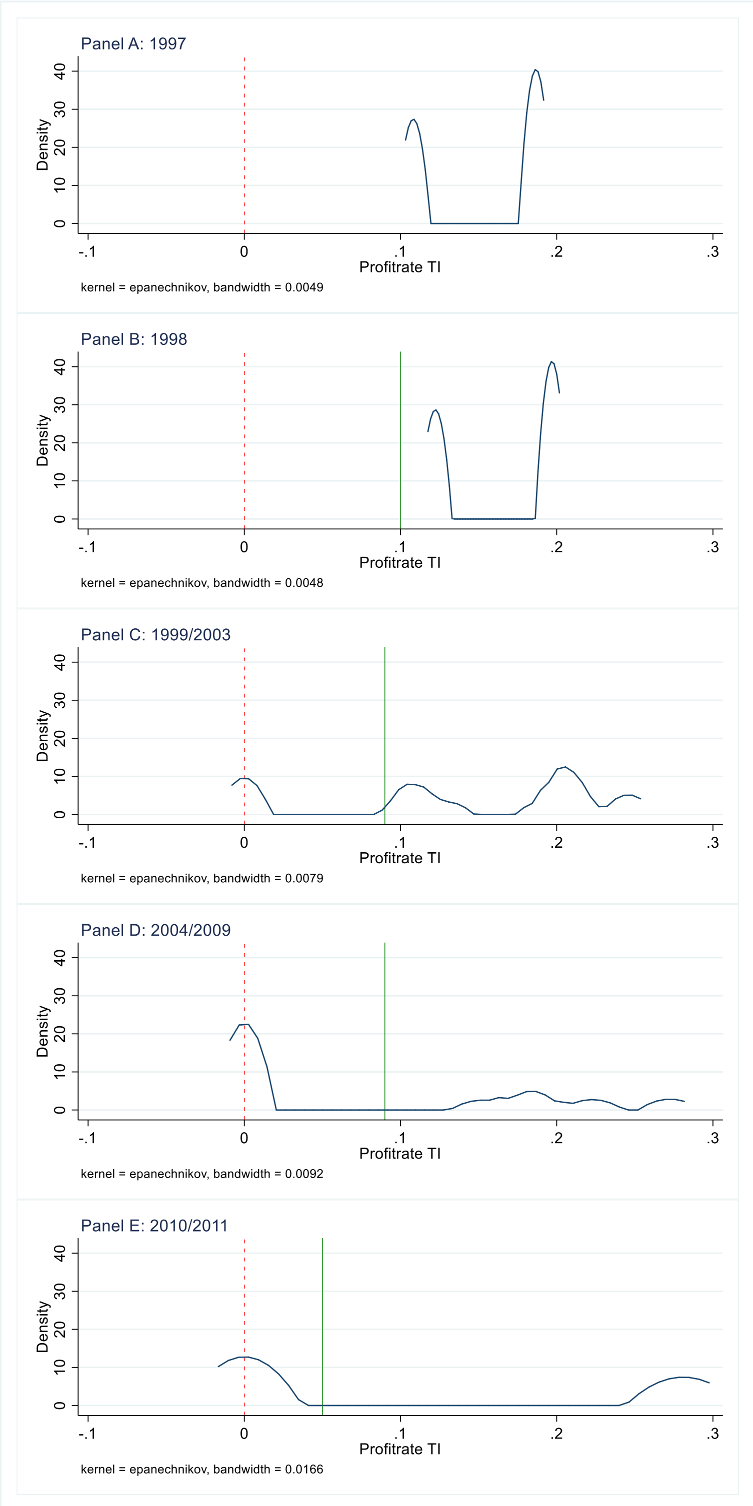
Figure B.2: Identification check, reported profit



Notes: Fig. B.2 shows the empirical Kernel density distribution of the profit rate (*reported profit* as a fraction of turnover). The zero profit rate is marked by a dotted red line. The green solid line shows the kink points calculated using $\tau_y(\text{min})$ and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05). The blue solid line shows the kink points calculated using $t_y(total, \text{min})$ and τ_π: 1998(0.2), 1999/2003(0.18), 2004/2009(0.25) and 2010/2011(0.31).

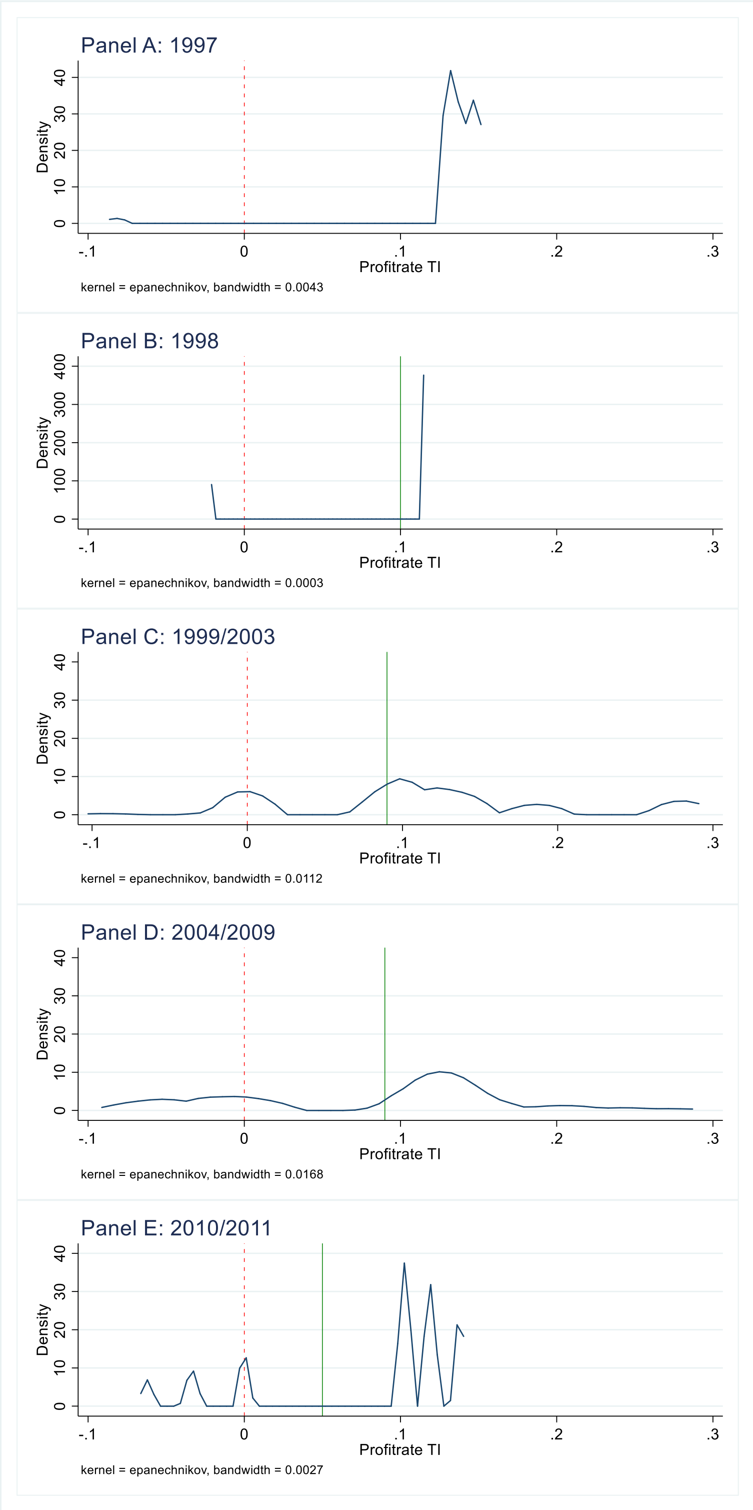
4.C Additional evidence: Bunching by size and eligibility

Figure C.1: Bunching evidence, small or eligible firms



Notes: Figure C.1 shows the empirical Kernel density distribution of the profit rate (*reported taxable income* as a fraction of turnover) for *small firms*. The green solid line shows the kink points calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05). The zero profit rate is marked by a dotted red line.

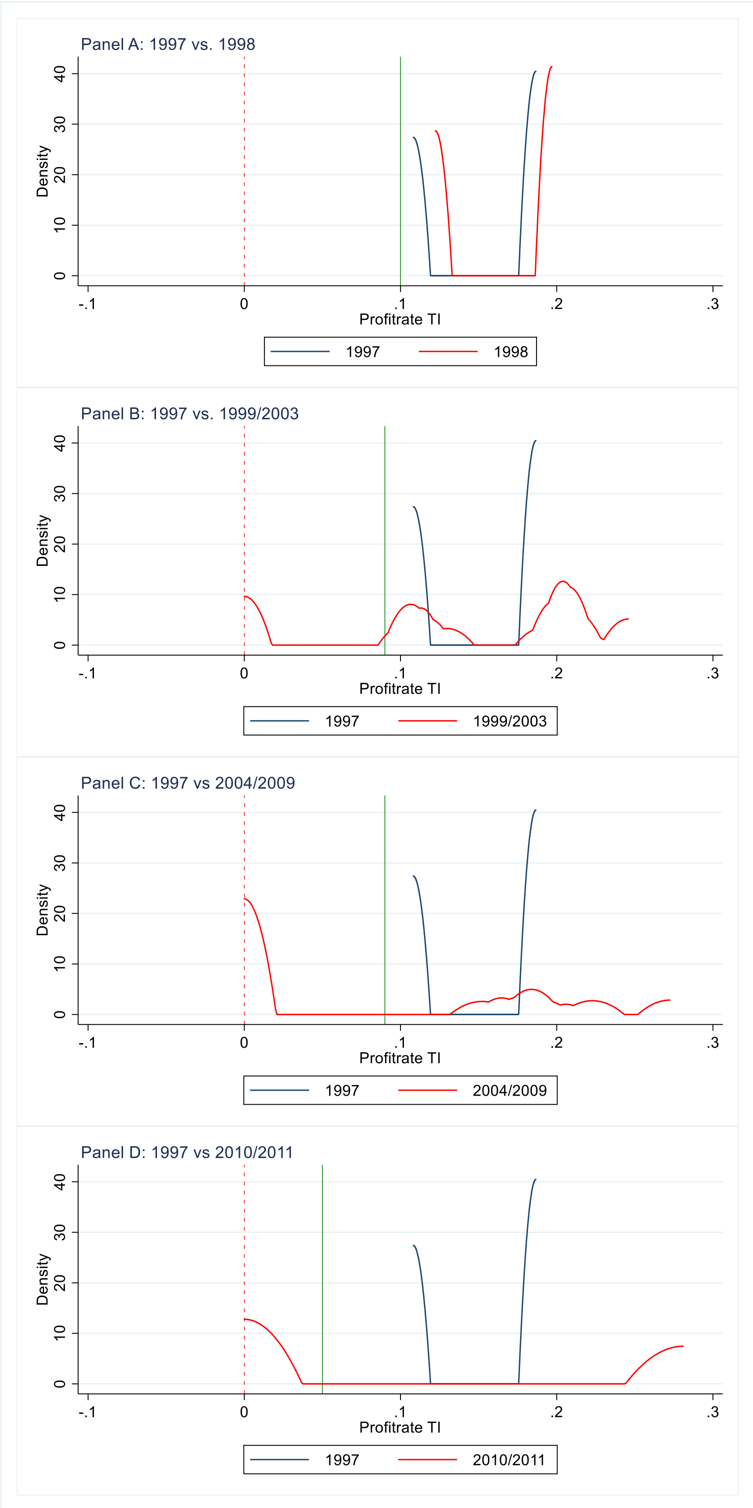
Figure C.2: Bunching evidence, large firms



Notes: Figure C.2 shows the empirical Kernel density distribution of the profit rate (*reported taxable income* as a fraction of turnover) for *large firms*. The green solid line shows the kink points calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05). The zero profit rate is marked by a dotted red line.

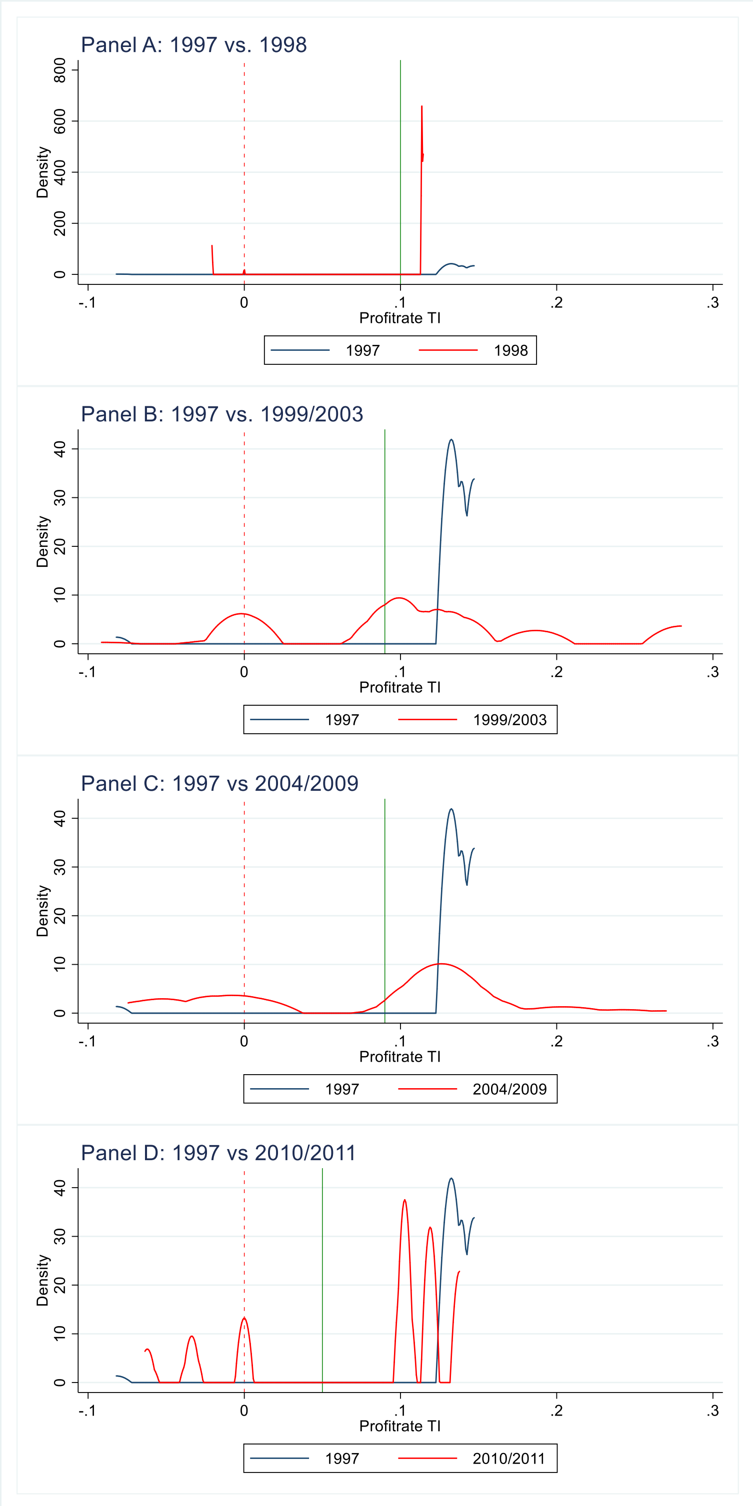
4.D Additional evidence: Dynamics of bunching

Figure D.1: Dynamics of bunching, small firms



Notes: Figure D.1 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *small firms* in 1997, 1998, 1999/2003, 2004/2009 and 2010/2011. The green solid line shows the profit rates calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05), and the zero profit rate is marked by a dotted line.

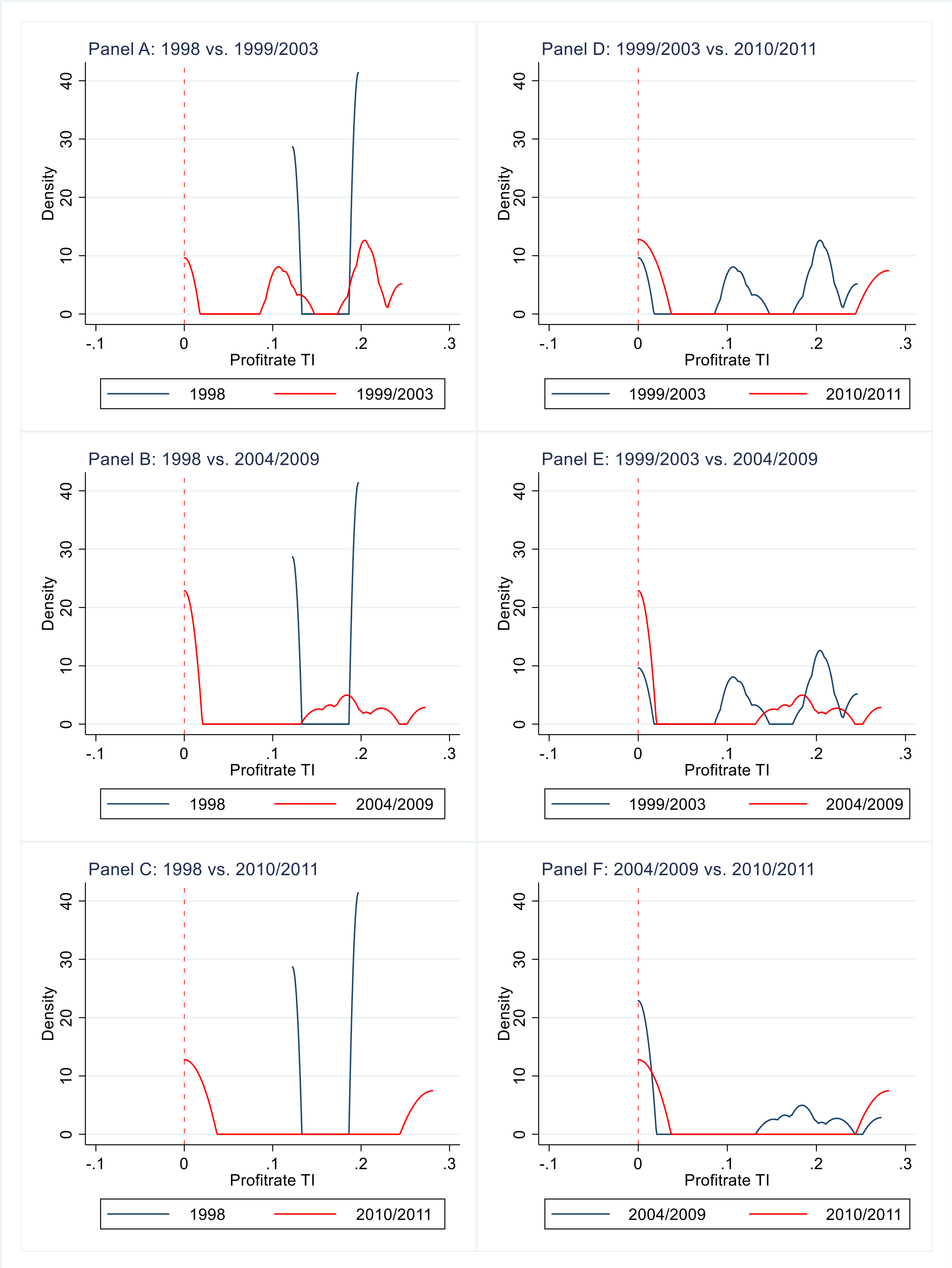
Figure D.2: Dynamics of bunching, large firms



Notes: Figure D.1 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *large firms* in 1997, 1998, 1999/2003, 2004/2009 and 2010/2011. The green solid line shows the profit rates calculated using τ_y(min) and τ_π: 1998(0.1), 1999/2003(0.09), 2004/2009(0.09) and 2010/2011(0.05), and the zero profit rate is marked by a dotted line.

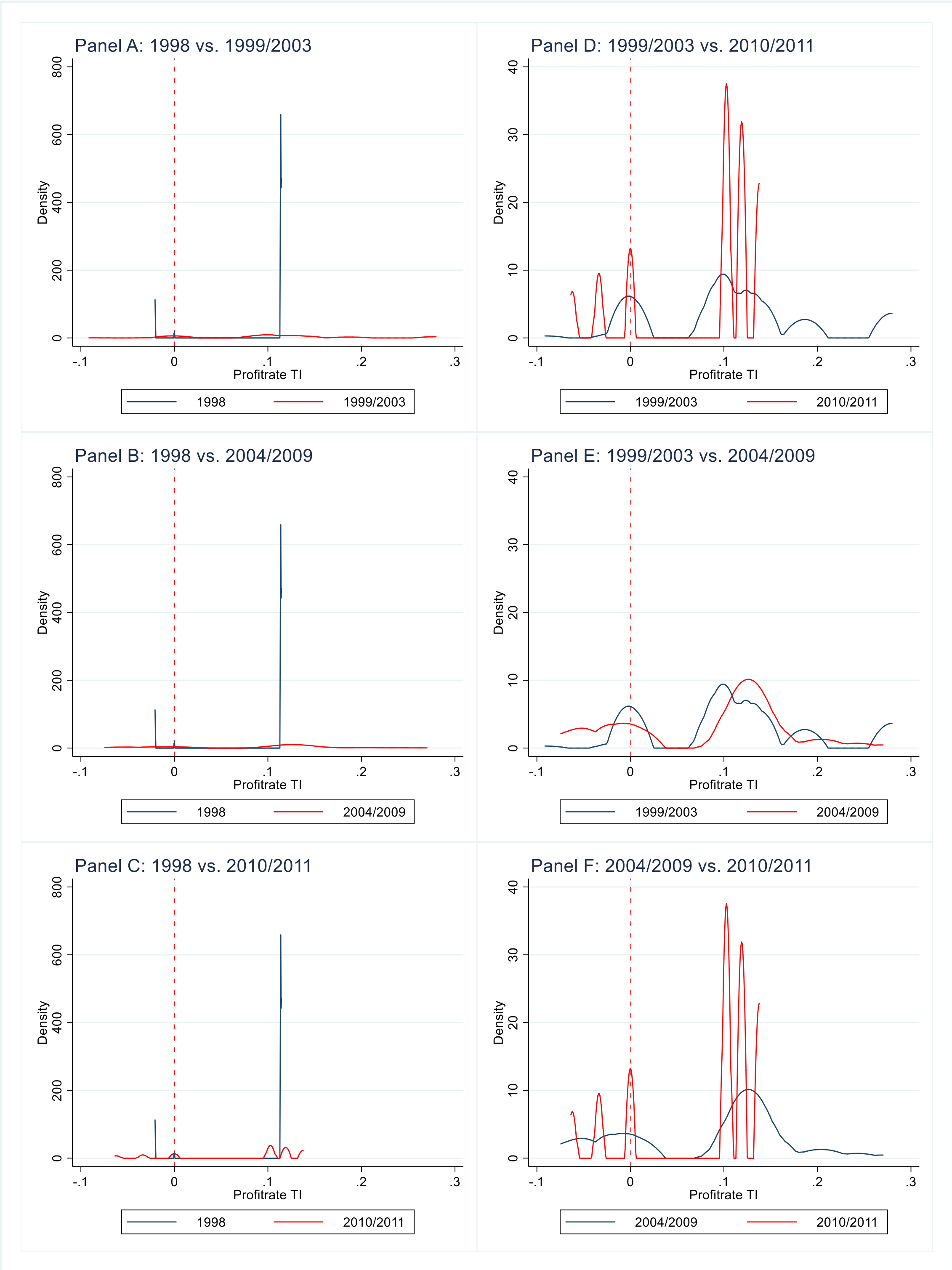
4.E Additional evidence: Robustness checks

Figure E.1: Robustness checks, small firms



Notes: Figure E.1 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *small firms* in each time period. The kinks are at a profit rate: 0.1 (in 1998), 0.09 (in 1999/2003), 0.09 (in 2004/2009) and 0,05 (in 2010/2011).

Figure E.2: Robustness checks, large firms



Notes: Figure E.2 shows the empirical Kernel density distribution of the profit rate (reported taxable income as a fraction of turnover) for *large firms* in each time period. The kinks are at a profit rate: 0.1 (in 1998), 0.09 (in 1999/2003), 0.09 (in 2004/2009) and 0,05 (in 2010/2011).

Chapter 5
Concluding remarks

Governments increase tax revenue to finance public goods and to redistribute income. In developing countries, this requirement is indispensable for development and poverty reduction. However, tax policies have important effects on distribution and efficiency. Taxes alter households' and firms' economic decisions, which result in a less efficient allocation of resources (Dahlby 2008). Therefore, a central concern facing any government is how to increase public spending through taxation without generating substantial social costs (Feldstein 1996). To address this, public finance economists have focused their attention on studying the behavior of economic agents with respect to taxes. After all, the design of more efficient tax systems requires to know: (i) Do economic agents respond to taxation? (ii) Who are the most responsive? (iii) How do they respond, through which channels (i.e. the anatomy of the responses)? (iv) When do they respond most, at the short-, medium-, or long-run (i.e. the timing of the responses)? The present thesis has been entirely devoted to answering to these questions.

Chapter 2 estimates the ETI with respect to the net-of-tax rate in Spain, by using tax return microdata from 2010-2014 and the bunching approach. It shows that Spanish taxpayers are sensitive to taxes and to tax modifications. As a matter of fact, the speed of reaction raises the possibility of compliance responses being more important than real supply responses. In addition, this chapter identifies and classifies for the first time five different forms of bunching: bunching-holes, holes, agglomerations, interior bunching and asymmetric bunching. This indicates that individuals' decisions may be influenced by optimization frictions, psychological components and adjustment costs. Furthermore, the identification of bunchers suggests that married couples, taxpayers filing separately and wage earners are the most responsive groups in the Spanish population. Surprisingly, I find that having a child make women less sensitive to taxation. Further exploration of the anatomy of responses reveal that bunching is caused by itemized deductions. In particular, for married couples, for men and for wage earners the contribution to pension schemes seems to be the main channel through which taxable income is adjusted. Overall, the empirical results show that Spanish taxpayers respond to taxation and adjust their taxable income through itemized deductions.

Chapter 3 assesses the impact of the 2011 PIT reform on tax revenue, welfare and efficiency. Using the Two-Stage Least Squares (2SLS) method and a panel of tax returns from 2009 to 2014, this chapter rises four main results. First, the elasticity estimates suggest that women are more sensitive to marginal tax rate changes than men. Second, the welfare cost of raising an extra euro of tax revenue is found to be well in excess of a euro, especially in the year immediate to the tax reform. Third, results reveal important differences on efficiency costs depending on individuals' socio-economic characteristics. In particular, it is more expensive to rise an additional euro of tax revenue in Catalonia than in Madrid and among self-employed individuals than among wage earners. Fourth, findings show that tax revenue losses get smaller when income shifting possibilities are introduced into the analysis. This empirical application makes evident the crucial role played by the ETI and income shifting responses in the evaluation of tax reforms. Accordingly, from an applied point of view, these results are extremely useful as they shed lights on the design of tax policies and tax revenue forecasting.

Chapter 4 analyzes empirically the trade-off between revenue and production efficiency in the choice of tax instruments in a developing country. This study exploits the introduction of a Simplified Tax Regime in Argentina based on the bunching approach and on administrative tax data for the period 1997-2011. Results reveal that firms respond to the taxation component of the policy. In particular, this chapter shows that the policy provides small and medium firms with an additional incentive to reduce their turnover ("legally" or "illegally") and to move towards the Simplified Tax Regime. The contributions of this study to the literature are threefold. First, it provides direct empirical evidence on firms' margin responses to a widespread and questionable policy in Latin America with scarce quantitative evidence. Second, it contributes to the nascent literature that uses the bunching approach to estimate firm responses to tax changes. Third, it contributes to the analysis of the relation between informal firms, evasion and taxation in developing countries.

On the whole, this thesis answers to the aforementioned requirements needed for the design of more efficient tax systems. (i) Do economic agents respond to taxation? For two different environments, Chapters 2 and 4 confirm that Spanish individuals and Argentinean firms respond to tax modifications. (ii) Who are the most responsive? For the Spanish population, Chapter 2 identifies that the most sensitive groups are married couples, taxpayers filing separately, wage earners, and men and women depending on the type of household. For the Argentinean context, Chapter 4 identifies medium firms as the most responsive group. (iii) How do they respond, through which channels (i.e. the anatomy of the responses)? Chapter 2 raises the possibility of itemized deductions; in particular, the deductions to pension plan contributions, as a channel used by men, married couples and wage earners to respond to tax changes. Chapter 3 adds income shifting between tax bases as a potential channel used by personal income taxpayers. With regard to firms, Chapter 4 brings up turnover evasion as a possible channel used by small and medium enterprises in Argentina to respond to tax modifications. Still, further analysis is required on this matter. (iv) When do they respond most, at the short-, medium-, or long-run (i.e. the timing of the responses)? It is unclear when the responses are more predominant. At first sight, Chapters 3 and 4 suggest that short-run responses may be important, but it depends on the specific context under study. Finally, the underlying motivation of these questions is to confirm whether behavioral responses have an effect on tax revenue, efficiency and welfare. On this matter, Chapter 3 uses the Spanish PIT to show that a substantial fraction of tax revenue is lost through behavioral responses. However, as has been demonstrated throughout this thesis, the magnitude of the behavioral response and therefore of the efficiency costs strongly depend on taxpayers' socio-economic characteristics and on the length of the time-window over which the behavioral response is observed.

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